23rd International Balkan Workshop on Applied Physics and Materials Science

BOOK OF ABSTRACTS

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BOOK OF ABSTRACTS

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Topics

1. Materials Physics

- Semiconductors, Dielectrics and Organic Materials
- Spintronics, Magnetism and Superconductivity
- Crystal growth, Surfaces, Interfaces and Thin Films
- Polymers and Amorphous Materials

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- Laser Physics and applications
- Plasma Physics and applications
- Optoelectronics and photonics
- Applied and non-linear optics
- Ultrafast phenomena and applications

3. Nuclear and sub-Nuclear Physics and Applications

- Nuclear and subnuclear sciences and Engineering
- Advanced detection systems
- Accelerated particle beams
- Nuclear Techniques and applications
- Nuclear Safety and Radiation Protection

4. Cross-disciplinary Applications of Physics

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- Biological complexity and genetics, Biophysics and bioengineering
- Econophysics
- Physics of Social Systems

5. Engineering and Industrial Physics

- Physics of energy transfer, conversion and storage
- Environmental Physics
- Sensors and Device Physics
- Micro- and Nanoelectronics
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- Imagining, Microscopy and Spectroscopy and their applications
- Instrumentation, processing, fabrication and measurement technologies
- Applications of fluid mechanics and microfluidics

6. Topics in Physics Education Research

- Physics curriculum design
- Active learning techniques
- Classroom teaching, demonstrations and laboratory experiments

Topics Program

Plenary

DAY	TIME	ROOM
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	10:45– 11:30 – plenary presentations	Aula B
FRIDAY	09:00 – 09:45 – plenary presentations	Aula B
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1. Materials Physics – Section 1

DAY	TIME	ROOM
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FRIDAY	10:15 - 12:00 - invited & oral presentations	Aula B
SATURDAY	10:15 - 11:30 - invited & oral presentations	AB1

2. Laser, Plasma and Radiation Physics and Applications

DAY	TIME	ROOM
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3. Nuclear and sub-Nuclear Physics and Applications

DAY	TIME	ROOM
THURSDAY	12:00 – 13:00 - invited & oral presentations	AB1
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4. Cross-disciplinary Applications of Physics

DAY	TIME	ROOM
THURSDAY	12:00 - 13:00 - invited & oral presentations	S20
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	14:00 – 15:00 - **Poster** session	Aula B

5. Engineering and Industrial Physics

DAY	TIME	ROOM
THURSDAY	14:15 - 16:00 - invited & oral presentations	Aula B
FRIDAY	14:00 – 15:00 - **Poster** session	Aula B

6. Topics in Physics Education Research

DAY	TIME	ROOM
THURSDAY	16:00 – 16:45 - **Poster** session	Aula B
SATURDAY	10:15 - 10:45 - oral presentations	S 20

ABSTRACTS

S0 – PLENARY SESSION

SO 01

NATURE AND PHYSICS

What's better? To think or to experiment?

Roman SCHRITTWIESER

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In this presentation I would like to discuss a few rather unconventional and perhaps even provocative thoughts concerning the complicated relation between the human way of thinking and the multiple attempts of humans to understand, explain, predict and eventually utilize – for better or for worse – the "laws" of nature.

First I would like to clear up a common misapprehension, namely that "pure" thinking would be, by all accounts, better for explaining what's going on around us than to observe and consult nature and to try to learn from her. This fallacy dates back to the old Greek philosophers, in particular to the "most famous" of them, namely Aristotle [1]. He was probably the most influential philosopher who had the nerve to claim that "thinking" must be enough to understand nature. This inevitably led humans also to the prejudice that "pure thinking" supposedly is something higher, more exalted and learned than handicraft and to do experiments.

For many centuries Aristotle's scripts were considered more than sufficient to understand the world. But in many statements he was as wrong as possible, as we know from many of his claims about nature's laws, e.g. that heavier bodies fall faster to ground than light bodies. And it took almost 2000 years – until Galileo Galilei's legendary experiment on the Leaning Tower of Pisa, until reality was accepted.

About the same time as Aristotle, other Greek philosophers, as e.g. Empedocles [2], were very close to discover electricity after noticing that rubbing amber can attract fluffs. Not for nothing the Greek word for amber is „electron" (ἤλεκτρον). In our world, however, the electric properties of amber and other dielectrics were re-discovered only after the 16th century, when Renaissance began, terminating the stagnation of human knowledge that to my conviction had its origin about half a century B.C., when Greek philosophers claimed that experiments were something primitive and clumsy. E.g., after Archimedes [3] found the principle named after him that the upward buoyant force exerted on a body immersed in a fluid is equal to the weight of the fluid that the body displaces, a few other Greek philosophers were full of contempt for Archimedes, defaming him that he had just bungled around.

While these and later "philosophers" were feeling too to conceited to get dirty fingers experimenting with nature, they tried in vain to solve nature's great secrets by "thinking". But what they claimed was most often just false. It was the Renaissance which brought the greatest turn of science leading to a virtual explosion of humanity's knowledge and within 400 years of natural sciences many more laws of nature were found and exploited than within 4000 years of "philosophy" prior to that. (Volker Dittmar, 2023 04 27).

If from the heyday of the Roman empire a man had suddenly been transferred to the end of the Middle Ages (so about 1500 years in his future) he would not have had many problems to understand most devices and machines at that time, e.g. windmills, water mills, water pumps etc., driven by wind or water, fire or human or animal power. But another transfer just a few hundred years into the modern era, he would not have understood most devices since he had no knowledge of electricity.

Keywords: Theoretical Physics, Experimental Physics

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[2] https://en.wikipedia.org/wiki/Empedocles
[3] https://en.wikipedia.org/wiki/Archimedes

SO 02

100 YEARS OF QUANTUM MECHANICS: QUANTUM DEVICES AT ROOM TEMPERATURE

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The discovery of quantum mechanics 100 years ago, has completely changed our understanding about the world. We cannot think today neither the solid-state physics nor its main materials for study such as metals, the semiconductors or insulators without quantum mechanics. We present and overview of the last results of the application of quantum mechanics in the area of quantum devices. We are used to think that quantum devices work at low-temperatures, due to the focusing of the quantum computing technologies. However, the majority of quantum devices are working at room temperature such as lasers, tunneling electronic devices and many others which were discovered after the main discovery of the atomically thin materials 20 years ago. The most prominent atomically thin material is graphene which has created the possibility to research and fabricate at the wafer level a multitude of quantum devices at room temperature. At room temperature, the mean-free-path of graphene monolayers is 400 nm. Since the transport of carriers is ballistic within mean-free-path dimensions and these dimensions are within the features of electron-beam lithography, graphene is the ideal materials for evidencing quantum effects at room temperature. Our talk will review the theoretical and experimental work of quantum devices at room temperature regarding ballistic devices, tunneling, quantum gates, Bloch and the fully control of the Mott transitions, i.e the opening or closing the gap in certain materials named Mott materials. As example, we present in Fig. 1. The quantum electronics at atomic scale and at room temperature is the next major discovery based on quantum mechanics beyond classical CMOS technology [1]. In Fig. 1 it is depicted the first Mott transistor based on NiO/hafnium-based ferroelectrics.

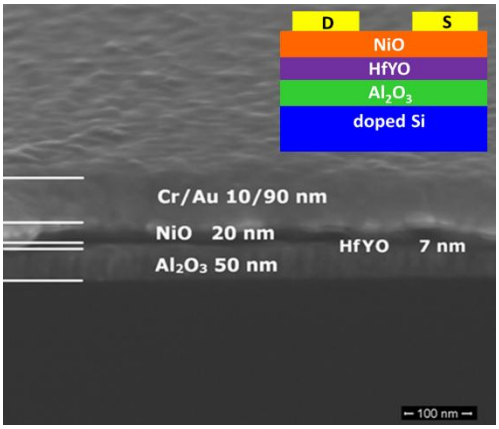

Fig.1 The first Mott transistor based on NiO/ hafnium-based ferroelectrics.

Keywords: atomically thin materials, ballistic devices, tunneling, Bloch oscillations, Mott transitions

[1] M.Dragoman and D.Dragoman, *Atomic-scale electronics beyond CMOS*, Springer, Cham, Switzerland (2021).

SO 03

EXTREME LIGHT INFRASTRUCTURE – NUCLEAR PHYSICS STATUS UPDATE

For the ELI-NP team Ioan DANCUS

Extreme Light Infrastructure - Nuclear Physics, IFIN-HH, 30 Reactorului Street, 077125 Magurele, Romania

The Extreme Light Infrastructure – Nuclear Physics (ELI-NP) is a cutting-edge European research center situated in Bucharest-Măgurele, Romania. It features two main advanced systems: a high-intensity laser and a tunable, high-brilliance gamma beam source [1,2]. Since early 2020, the facility has been providing laser pulses at nominal powers of 100 TW, 1 PW, and 10 PW to its experimental areas through the user access program. The High Power Laser System (HPLS) at ELI-NP currently holds the distinction of being the most powerful laser system in the world, regularly delivering 10 PW pulses for experimental use [3,4].

IFIN-HH/ELI-NP also oversees two significant projects: "Medical Applications of High-Power Lasers – Dr. Laser" and the Centre for High Power Optics.

This presentation will offer a technical overview of the ELI-NP infrastructure, highlighting its capabilities and the latest developments in its research and development programs.

Keywords: high power lasers, ultra-high intensity lasers, scientific facilities

Acknowledgements: This work was supported by the Extreme Light Infrastructure Nuclear Physics (ELI-NP) Phase II, a project co-financed by the Romanian Government and the European Union through the European Regional Development Fund the Competitiveness Operational Program 065208-5 (1/07.07.2016, COP, ID 1334), by the PN 23 21 01 05 and the LAS-COMB ELI-Ro contract funded by the Romanian Ministry of Research, Innovation and Digitalization and the IOSIN 2023 funds for research infrastructures of national interest. The work was partially supported by the European Union and the Romanian Government within the Romanian Health Program of the project "Medical applications of high-power lasers - Dr. Laser" Cod SMIS: 326475.

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SO 04

PHOTOVOLTAIC CELLS BASED ON ORGANIC MONOMERIC AND POLYMERIC THIN FILM

Ştefan ANTOHE [1,2]

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The interest in the study of the organic photovoltaic cells increases in the last decades, due to the spectacular increasing of the power conversion efficiency (PCE), from 1-2 %, [1] to more than 19.2 % today [2]. This study present the progress in the field of the organic photovoltaic cells based on small molecules and polymeric absorbers respectively, at the Research and Development Centre for Materials and Electronic and Optoelectronic Devices, at Faculty of Physics of the University of Bucharest.

Single-layer, two-layered, three-layered organic photovoltaic cells based on small molecules and single-, bi-layered and blended polymeric photovoltaic structures were prepared, characterized and analyzed their performances. [1].

In the case of PV structures based on small molecules the key to obtain high efficiency is to prepare bi-layered or multi-layered structures where the „co-sensitization effect" is highly activate, to enlarge the photoactive region and to optimize the design of the structures for a low series resistance, high shunt resistance and good collection of the photogenerated charge carriers. All these confer also a good stability in time but unfortunately a relatively high cost of the structures [3,4]

The studies of the more cheap photovoltaic cells based on the polymeric thin films lead to the same conclusion, that the high efficiencies could be obtained from bi-layered structures and especially from polymeric blends where the Donor/Acceptor (D/A) heterojunctions, responsible for the dissociation of the excitons and the separation of the photogenerated charge carriers, are spread in the whole volume of the thin film leading to so call „Bulkheterojunction" structures. Low cost and high efficiency of ~19% of the structures based on polymers make them potential candidates for commercially available solar cells and modules for low energy consumers[1]. Unfortunately, the stability in time of these systems is poor, in our opinion the main causes being the dissociation of excitons, the transport of the photogenerated charge carriers toward the electrodes and their collection at the interfaces Blend/Electrode. In our study we showed that using different buffer layers (as hole transporter (PEDOT: PSS) or electron transporter (LiF)) between the blend and electrodes or replacing the conventional transparent and conductive electrode ITO with other TCO (ZnO, IZO, IGZO, etc), the performances and the stability of the cells were improved. Also, the test of different composites (polymers with organic or inorganic nanostructured materials) and replacement of fullerene derivatives as acceptor with other Non Fullerene Acceptors (NFA), could be different ways to improve the performances of the polymeric cells[5-6].

Keywords: CuPc; TPyP; P3HT; 1,10 Phenanthroline;

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ABSTRACTS

S1 – Materials Physics

- *Semiconductors, Dielectrics and Organic Materials*
- *Spintronics, Magnetism and Superconductivity*
- *Crystal growth, Surfaces, Interfaces and Thin Films*
- *Polymers and Amorphous Materials*

S1 L1

THE IMPACT OF METALLIC ELECTRODES ON THE OLED PERFORMANCES

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OLEDs make pluralistic displays with the highest quality and lowest cost possible, ensuring high external quantum efficiency. The lifetime of OLEDs at typical brightness levels far surpasses the average lifetime of state-of-the-art mobile phones. The high light output is connected to the electrodes' transparency and the OLED balancing charge injections. Excess carriers will cause exciton-polar quenching and a narrow recombination zone due to an unbalanced charge distribution. This problem can be solved by increasing the hole density or, more practically, by lowering the cathode thicknesses, which also impact the transmission of light through the cathodes up to 80%.

However, lowering the cathode thicknesses limited the electron conductivity and charge distribution, which decreased the performance of the OLED devices. This fact is connected with the mean free path of the electrons in very thin cathodes, which increases the resistivity, requiring a higher applied voltage and reducing the external quantum efficiency of the OLED functionality.

For the best performance, a compromise between the thickness and the efficiency of the electron injection can be achieved, leading to an optimal thickness of about 3-4 times the mean free path of electrons, a parameter that depends on the type of metal. This fact ensures a lower transmittance through the cathode thin films but an optimal electron injection that balances the hole charges and increases the density of the formed excitons.

With increasing current density, the exciton density increases rapidly along with severe exciton quenching, influencing the quality of the light. This is the case for the 8 K televisions with ultrahigh definition and high color saturation.

In terms of device preparation technology, the development of more precise control technology in device preparation processes will greatly improve the reliability and repeatability of OLEDs.

Keywords: OLED, metallic electrodes, charge injection, external quantum efficiency.

S1 L2

POLARIZATION-INDUCED MOLECULAR ADSORPTION ON FERROELECTRIC SURFACES FOR NEW DECARBONIZATION TECHNOLOGIES

Alexandru-Cristi IANCU[1,2], Nicoleta G. APOSTOL[1], Adela NICOLAEV[1], Laura E. ABRAMIUC[1], Cristina F. CHIRILĂ[1], Dana G. POPESCU[1], George A. LUNGU[1], Cristian A. TACHE[1], and Cristian M. TEODORESCU[1]

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Although in the last years there was increasing evidence of the remarking catalytic properties of ferroelectric materials, the fundamental processes involved are still under debate. Since an essential step of these processes consists in molecular adsorption, the studies presented in this contribution concentrate on the influence of the ferroelectric state of the adsorption processes. A pre-requisite for such studies is the cleanness of the sample surface, together with its good crystallinity, in order to work on a system as close as possible on the ones supposed by theoretical modelling. This was

achieved for the first time almost one decade ago, on lead zirconate titanate (PZT) thin films, where a cleaning procedure involving extended annealing in oxygen allowed one to synthesize surfaces with no carbon contamination as investigated by synchrotron radiation X-ray photoelectron spectroscopy (SRXPS) in an enhanced surface sensitivity regime and crystallinity revealed by low energy electron diffraction (LEED) [1]. This film was in a well-defined polarization state oriented inwards and it was found that carbon monoxide is adsorbed and partly dissociated on this surface. Carbon is then desorbed in form of carbon dioxide when the substrate is heated above the Curie temperature. Therefore, these experiments indicate the clear interplay between the polarization state and adsorption/desorption processes. Since carbon monoxide has a very low dipole moment (about 0.1 Debye), a mechanism involving the polarizability of the molecule by the field generated by the ferroelectric surface was established, yielding a binding energy proportional to the square of the substrate polarization [2]. The drawback of these processes is that when one tries to get rid of the adsorbate by heating the substrate above the Curie temperature, carbon uptakes oxygen from the substrate. Therefore, the surface is depleted in oxygen and is not stable upon several cycles of adsorption/desorption. On the contrary, for a substrate with lower polarization, such as barium titanate (BTO) with about one quarter of the polarization of PZT, the interaction energy is lower than the dissociation energy and therefore molecules are adsorbed without dissociation. Upon heating the substrate, molecules are desorbed without affecting the substrate. It is shown in which cases the molecules (CO, C_2H_2 and CO_2) are adsorbed and dissociated (on PZT [1]) or not (on BTO [2–4]), how for dissociated molecules some atoms/ions are ejected or attracted to the surface, and how molecules adsorbed in non-dissociated states form additional bonds with atoms from the first layer of the ferroelectric surface. It follows that exploring the use of barium titanate is highly desirable, since this material is abundant, non toxic, relatively cheap, and can provide the ability of reversible molecular adsorption/desorption of carbon-containing molecules from the ambient atmosphere.

An estimate of carbon dioxide adsorption ability based on these experiments yielded a capacity of about 8 mg CO_2 per g of material for 20 nm sized barium titanate powder, by supposing that the ferroelectric properties are similar to the bulk. A scale-up of this finding yields a necessary of about 1.2 million tons BTO with an initial price of 2–3 billion USD to remove 10 billion tons carbon dioxide per year, by using a total power of about 40 GW (30 billion USD per year). Complete decarbonization could then be achieved in about 20 years.

Keywords: ferroelectrics, adsorption, desorption, decarbonization.

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S1 L3

CARBON-SILICON- TITANIUM - ALUMINUM NANOSTRUCTURES DOPED WITH NITROGEN: SYNTHESIS AND CHARACTERIZATION

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Using Thermionic Vacuum Arc technology were created nanostructured thin films using four material: graphite, titanium, silicon, and aluminum, with the inclusion of nitrogen, on the Si substrate. TDS analysis reveal the presence of nitrogen in all cases. The Raman spectra show that the nitrogen treatment of the films leads to the formation of nitrides for each compound. The infrared absorption spectra are dominated by the formation of C-N bonds exactly as in Raman spectra. EDX and Elemental composition show that the values of atomic percentage depending of the substrate deposition temperature. EDX and STEM mapping was carried out to evaluate sample composition. Based on XPS depth profile it turns out that . the peaks of the three materials Si, Al and Ti are well defined whereas O concentration is much lower, due to the high working temperature. Based on nanoidentation studies, Young modulus and Hardness are measured.The values of the Hardness in the case of N-doped thin films are generally bigger compared with the values in the case of undoped films. The tribology data reveal that the values of the friction coefficient in the case of N-doped thin films are generally smaller compared with the values in the case of undoped films. Electrical conductivity on the Ti-Si-Al-C-N films shows the increase of conductivity with the increase of the nitrogen content.

Keywords: TVA technology, TDS, Raman, EDX, STEM, XPS, nanoidentation, tribology.

S1 L4

SKYRMIONIC QUBITS AS PLATFORMS FOR QUANTUM COMPUTING APPLICATIONS

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Recent theoretical predictions [1] indicate that the nanometer-sized skyrmions can encode quantum information in their helicity degree of freedom that can be manipulated using electric or magnetic fields, within a wide operating range providing a large anharmonicity. These type of skyrmions are stabilized by competing exchange interactions in the absence of the Dzyaloshinskii–Moriya interaction (DMI) that would lock the helicity degree of freedom. However, the conventional skyrmionic spintronic applications are mostly based on the DMI mechanisms and their control in skillfully tailored architectures [2] . To fulfil this criterium and take profit on all existing knowhow in skyrmionic materials and applications in information technologies, we investigated the classic and quantum skyrmionic states stabilized by DMI mechanisms. Our theoretical approach is based on a quantum exact diagonalization framework developed for several 2D spin lattice models of variable

geometry, symmetry and size. We show that the open boundary conditions mainly lead to classic skyrmions, like those classically described using micromagnetic tools. However, an interesting and robust quantum skyrmionic phase can be stabilized when imposing periodic boundary conditions, in a specific range of the phase diagram defined by the model parameters: DMI, direct exchange, anisotropy and magnetic field. We demonstrate the possibility to manipulate such kind of quantum skyrmions by external periodic and static field perturbations building Pauli-X,Y, Z- and Hadamard-gate quantum logical gates (Figure 1).

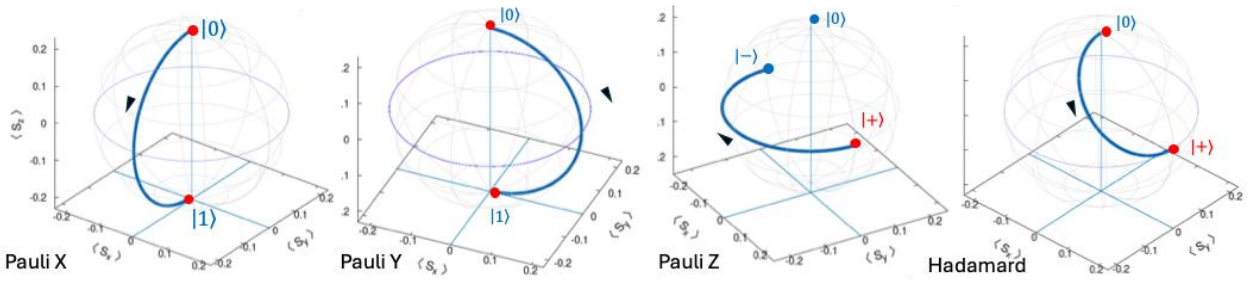

Figure 1. *Quantum gates based on quantum skyrmions*

Moreover, comparing the results obtained in 2D lattice model with those corresponding to 1D Ising spin models with DMI we illustrate the negative influence of the DMI on the coherent processional manipulation of quantum skyrmionic states. Moreover, we investigate the DMI induced quantum quench phenomena in 2D and 1D spin lattices with both periodic and open boundary conditions.

Our results indicate encouraging paths in designing new skyrmionic qubit devices for quantum spintronic applications based on the existing knowhow in the DMI controlled skyrmionic materials.

Keywords: quantum skyrmions, qubits, quantum spintronics.

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S1 O1

PHONON – ELECTRON COUPLING IN CdTe: THEORY VS EXPERIMENT

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A theoretical analysis of the phonon structure of exciton and impurity bands was performed and compared with experimental photoluminescence (PL) data for CdTe thin films [1]. The electron-phonon interaction is characterized by the Huang-Rhys factor (HRF) [2], which is defined as the average number of phonons emitted per photon during recombination. In the two-band approximation, the phonon replicas of excitons and carriers bound to impurity are characterized by the matrix element of the Fröhlich interaction [3].

The HRF for the exciton – LO phonon (N_{1S}) and impurity – LO phonon (N_{eA}) interactions in the Fröhlich approximation, considering a hydrogen-like form for the exciton (a_B) and impurity (a_A), has the following form:

$$N_{1S} = \frac{e^2\lambda_D}{\pi\hbar\omega_{LO}}\frac{1}{\varepsilon^*}\int_0^\infty \frac{dx\cdot x^2}{1+x^2}\left(\frac{1}{(1+x^2\alpha_e^2)^2}-\frac{1}{(1+x^2\alpha_h^2)^2}\right)^2, \qquad \alpha_{e,h} = \frac{m_{e,h}}{m_e+m_h}\frac{a_B}{2\lambda_D}$$
$$N_{eA} = \frac{e^2\lambda_D}{\pi\hbar\omega_{LO}}\frac{1}{\varepsilon^*}\int_0^\infty \frac{dx\cdot x^2}{1+x^2}\left(\frac{1}{(1+x^2\beta_h^2)^2}\right)^2 dx, \qquad \beta_h = \frac{m_h}{m_e+m_h}\frac{a_A}{2\lambda_D} \tag{1}$$

The Debye length λ_D characterizes the screening of the Coulomb potential. The resulting theoretical estimate (1) shows that the number of LO phonons emitted per photon during exciton annihilation is less than unity, indicating weak exciton-phonon coupling, whereas impurity recombination is characterized by strong phonon coupling. Experimental data [1] shows that the phonon replicas of the impurity band around 1.4 eV are significantly more pronounced than those of both free and bound excitons. Therefore, the theory is in good agreement with the experiment.

In addition, the PL form-functions for both exciton and impurity bands were calculated within the framework of two-particle Green's function approach in the Fröhlich interaction approximation, taking into account the HRF. The form-function of band carrier radiative recombination was analyzed taking into account phonon-plasmon coupling using the cumulant method.

Eventually, the Mott transition of excitons into an electron–hole plasma was analyzed. The Mott transition results in a significant drop in the HRF, which corresponds to the experimental observation of the suppression of phonon replicas with increasing temperature.

Keywords: CdTe, Photoluminescence, Huang-Rhys factor, LO phonons.

Acknowledgements: MEC subprogram 011207

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S1 O2

NICKEL OXIDE DOPING FOR ELECTROCHROMIC AND PHOTOVOLTAIC APPLICATIONS

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Nickel oxide (NiO) is a p-type semiconductor with a cubic rock-salt structure and a wide bandgap ranging from 3.6 to 4.0 eV. It is widely used in electrochromic devices as an anodic coloring material due to its high optical transparency (over 75% in the visible spectrum) and chemical stability. The electrochromic behavior of NiO is attributed to reversible redox reactions involving Ni^{2+}/Ni^{3+} transitions, which facilitate color changes upon ion insertion and extraction [1]. Undoped NiO exhibits relatively low electrical conductivity, typically around 10^{-2} to 10^{-3} S/cm, limiting its electrochromic performance. Enhancing the coloration switching speed and contrast requires

increasing the density and mobility of free carriers, thereby improving conductivity. To achieve the desired electrical properties, NiO can be doped with monovalent elements such as Li^+, Cu^+, Ag^+, and Na^+, which introduce additional charge carriers and modify the electronic structure [2].

In this study, Metalorganic Aerosol Deposition (MAD) [3] was used to prepare thin nanolayers of NiO:(Cu, Ag, Na)/Si(111). In the MAD process, a single homogeneous solution containing all necessary precursors was used. The deposition solution was prepared by dissolving 0.1 mol nickel acetylacetonate [$Ni(acac)_2$] along with 0.5-6.0 mmol of one of the dopant precursors – [$Cu(acac)_2$], [Ag(acac)] or [Na(acac)] – in 5 ml dimethylformamide (DMF). DMF serves both as the solvent and the transport agent, ensuring uniform distribution of the precursors during the deposition process. By varying the substrate temperature (400 – 550 °C) and dopant concentration in deposition solution (0.5-6.0 at.%), doped NiO films were success synthesized.

Grazing Incidence X-ray Diffraction experiments (GI-XRD) at 0.5° incidence angle were carried out, along with Rietveld refinement and Williamson–Hall plot analysis for structural investigations. Additionally, Atomic Force Microscope (AFM) was used to measure the surface roughness. The Energy-Dispersive X-Ray Spectroscopy (EDS) and X-ray photoelectron spectroscopy (XPS) was used for elemental analysis. Structural analysis showed that undoped NiO/Si (111) exhibits rock salt, secondary phase free, structure (lattice parameter about 4.221Å), average crystallite size being in the range of 14 nm. Elemental analysis revealed the following atomic concentrations: 61.63 at.% O; 38.37 at.% Ni. While NiO does not reveal any photosensitivity Cu, Ag and Na doped nickel oxide' exhibit photosensitivity in the UV spectral range with their photoelectrical and structural properties dependent on the dopant concentration. Current work brings together a complex analysis of NiO doping and their effect on their physical properties relevant for electrochromic and photovoltaic applications.

Keywords: Nickel oxide, doping, metalorganic aerosol deposition, electrochromic, photovoltaic

Acknowledgements: CNCS-UEFISCDI, project number 18ROMD/20.05.2024, project PN-IV-P8-8.3-ROMD-2023-0186, within PNCDI IV and MEC subprogram 011207

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S1 O3

ENHANCED MAGNETIC PROPERTIES OF COBALT FERRITES NANOPARTICLES FOR APPLICATIONS IN MEDICINE

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In the last years the applications of nanomaterials/nanotechnology in the biomedicine have attracted a lot of attention. Magnetic, magnetoplasmonic and magnetoelectric nanoparticles are now a hot topic, due to their unique properties and biocompatibility, having in view their applications in drug delivery, tumour targeting, theranostics, contrast agents in medical imaging and hyperthermia. We propose selected substitutions on tetrahedral sites to enhance the magnetic moments. For this reason we have studied the magnetic properties of cobalt ferrites, where Co was substituted by Zn or Mn. All samples were found to be single phases and have a cubic *Fd-3m* structure. EDS analysis confirmed the presence of cobalt, (zinc or manganese), iron, and oxygen without contamination. Raman spectra show clearly that Zn ions are preferentially located in tetrahedral sites for low Zn concentrations. In the compounds with Mn it was shown that Fe^{3+} would be placed on octahedral sites, Fe^{2+} would in turn be displaced to tetrahedral sites while Mn ions will be placed on both sites. Due to their high crystallinity, the nanoparticles show high values of the magnetization. The doping with Mn in nanocrystalline cobalt ferrite enhanced the magnetic properties due to changings in the cation distribution between the two sublattices. The higher magnetic moments are explained by the presence of Mn^{4+} ions located preferentially on tetrahedral sites while Mn^{2+} prefer octahedral sites. Co ferrite doped with 30% of Zn produced the largest SAR values, which increase linearly from 148 to 840 W/g_{MNPs} as the magnetic field is increased from 20 to 60 kA/m.

Keywords: manganese-cobalt ferrite nanoparticles, cation distribution, Raman measurements, magnetic properties

S1 O4

PHOTOCATALYTIC DEGRADATION OF ORGANIC DYES IN CONTINUOUS FLOW USING ELECTRODEPOSITED TiO_2 THIN FILMS

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The discharge of synthetic dyes such as methylene blue and rhodamine B into aquatic environments presents serious ecological and health concerns, due to their toxicity, chemical stability,

and resistance to biodegradation [1]. Among the available advanced oxidation processes, titanium dioxide (TiO_2) based photocatalysis has gained considerable attention for dye degradation, owing to its strong oxidative potential, photostability, and low cost [2].

This work investigates the fabrication of TiO_2 thin films via electrodeposition, a versatile method that enables precise control over film thickness, crystallinity, and morphology, factors known to critically affect photocatalytic performance [3]. Following deposition, the films are annealed to enhance the anatase crystalline phase, which is preferred for photocatalysis due to its optimal band gap and charge transport properties [4]. Structural and surface analyses were conducted using X-ray diffraction (XRD), Raman Spectroscopy, X-Ray Photoelectron Spectroscopy (XPS) and scanning electron microscopy (SEM), respectively.

The photocatalytic activity of the films was evaluated in a continuous flow system designed to mimic real wastewater treatment conditions more accurately than traditional batch setups. Continuous flow photoreactors offer significant advantages in terms of process control, scalability, and improved mass transfer [5]. Preliminary results indicate effective degradation of methylene blue and rhodamine B under UV light, consistent with previous findings on the activity of immobilized TiO_2 films in dynamic systems [6].

TiO_2 also demonstrates excellent chemical stability and reusability, making it a promising material for long-term application in wastewater remediation technologies [7]. Ongoing work aims to optimize reactor operating parameters including flow rate, film surface area, and light intensity as well as to investigate long-term performance and regeneration cycles.

These initial findings support the potential of electrodeposited TiO_2 thin films in continuous flow photocatalytic systems as a sustainable, efficient method for treating dye-contaminated wastewater.

Keywords: Photocatalysis, TiO_2 thin films, Continuous flow reactor, Dye degradation

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S1 O5

A CALORIMETRIC APPROACH TO THE FIRST ORDER REVERSAL CURVES METHOD FOR SPIN-CROSSOVER MOLECULAR MAGNETS

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In this study we present an alternative to classical magnetometric measurements for the First-Order Reversal Curve (FORC) diagram approach by using calorimetric experiments for the spin crossover compound $[Fe(btr)_2(NCS)_2]\cdot H_2O$ (btr=4,4'-bis(1,2,4-triazole). This coordination polymer has a 2D network structure and displays a hysteretic and complete spin transition below room temperature [1].

The main issue in the numerical calculation of the FORC diagrams is the computation of the second-order derivative of a function with discrete noise-contaminated data, which increases the noise that is inevitably present in the measurements [2]. To overcome the limitations of the standard method for obtaining FORC distributions, we propose here a more direct method, when calorimetric measurements are available (Fig. 1 a). By leveraging the fact that heat capacity is already related to the first derivative of the high spin fraction with respect to the temperature, only a single derivative is required to obtain FORC diagrams (Fig. 1 b) [3]. Also, the calorimetric approach simplifies diagram calculation when the reversal temperature step between successive cycles significantly differs from the measurement step within a single cycle. In this way, the calorimetric method provides a unique alternative to the classical FORC diagram approach.

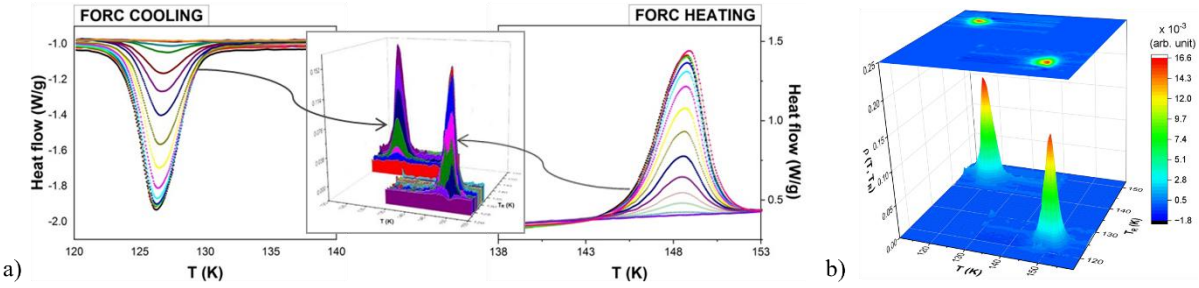

Fig. 1: a) FORC thermograms (sides) and FORC distributions (in the middle); b) FORC diagrams for $Fe(btr)_2(NCS)_2\cdot H_2O$ polycrystallites for calorimetric measurements.

An original method to calculate the thermograms was introduced using the Ising-like model, implemented through a Monte Carlo Metropolis algorithm with an Arrhenius dynamic. This method is used to calculate in a probabilistic manner the high spin fraction of the system. More interestingly, we can directly obtain the calorimetric curves, the heat flow being proportional to the number of molecules that switch their spin state at each temperature.

Keywords: spin crossover, FORC, heat capacity, calorimetry.

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S1 O6

MAGNETOCALORIC EFFECT, MAGNETOTRANSPORT AND MAGNETIC PROPERTIES OF POLYCRYSTALLINE POLYCRYSTALLINE AND NANO-SCALE MANGANITES $Pr_{(0.65-x)}Nd_xSr_{0.35}MnO_3$ ($x \leq 0.35$)

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This study presents research on the structural and magnetic properties of polycrystalline and nanocrystalline manganites $Pr_{(0.65-x)}Nd_xSr_{0.35}MnO_3$ ($x \leq 0.35$), which show high potential as magnetocaloric materials for magnetic refrigeration applications near room temperature. We describe the preparation route, characterization means, and how we can combine the magnetic properties of the two systems (bulk and nanosized compounds) to obtain better magnetocaloric materials. Different critical magnetic behavior of the polycrystalline and nanocrystalline samples was evidenced. Bulk compounds exhibit high and sharp peaks in magnetic entropy change. Nanocrystalline samples exhibit a very wide effective temperature range in the magnetocaloric effect but lower peaks in magnetic entropy change. Combining the magnetic properties of the nano- and polycrystalline manganite, a better magnetocaloric material can be obtained. To compare the magnetocaloric performances of the studied compounds, both relative cooling power (*RCP*) and temperature-averaged entropy change (*TEC*) figures of merit were used. *RCP* is comparable for bulk polycrystalline and nano-sized samples of the same substitution level, while *TEC* shows a large difference between the two systems. The combination of bulk and nanocrystalline materials can contribute to the effectiveness and improvement of magnetocaloric materials. All compounds exhibit second-order magnetic phase transitions and relatively high magnetic entropy change, with the highest value of 5.74 J/kgK for x = 0.25 bulk sample. Strong magnetocaloric effect, stability, and the possibility of fine-tuning T_c by Nd ions substitution make the investigated bulk polycrystalline compounds promising for application in magnetic refrigeration. Nano-sized samples possess lower magnetic entropy changes of a maximum 2.4 J/kgK but wider effective entropy change temperature (δT_{fwhm}) and relative cooling power on par with other manganites, bringing them into the conversation as a viable option in cooling materials.

Keywords: Perovskite manganites, Nanoparticles, Critical behavior, Magnetocaloric effect

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S1 O7

INDUCED EFFECTS OF PROTONS IRRADIATION ON SOME PHYSICAL PROPERTIES OF ZnTe THIN FILM

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Zinc telluride (ZnTe) is an A^{II}-B^{VI} semiconductors, with promising results in the field of photovoltaic devices. Even though the heterojunction cadmium sulfide / cadmium telluride (CdS/CdTe) proved to be a suitable candidate to replace a part of the silicon technology, with good performances for terrestrial and space applications, the hazardous properties of cadmium request the finding of a better solution. In this sense, binary compounds based on zinc (Zn) can be an alternative. Until now, the majority of studies related to ZnTe as an absorber layer were reported only for solar cells used in terrestrial applications, while space utilisation was scarcely discussed. Related to space utilization, characterization of the material post-irradiation should be made.

This study analyses and discusses the effects of proton irradiation on the optical, morphological, structural, and electrical properties of ZnTe thin films. Previous results obtained for irradiated CdS/CdTe-based photovoltaic structures indicated an increase of point-like defects density at the "window" layer / active layer interface, together with a decrease in the external quantum efficiency[1]. Other studies showed that when zinc oxide was used as transparent conductive oxide instead of indium tin oxide, the overall stability against ionising radiation was improved. [2]

We choose protons because they represent 80% of the ionizing radiation in space, while fluency and energy are similar to studies from the literature, involving CdTe.

Future work to obtain a proper heterojunction as a " window" layer instead of CdS will involve using ZnSe. The ZnSe thin film will be also irradiated with protons and its physical properties will be investigated, using the same approach as in the case of ZnTe film.

In this manner, by knowing the behaviour of both components of a possible junction, we can predict the performance of some devices.

Keywords: ZnTe thin film, proton irradiation, magnetron sputtering

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S1 O8

MORPHOLOGY AND MICROSTRUCTURE OF ADVANCED TUNGSTEN MATERIALS WITH CR AND V DISPERSOIDS INTENDED FOR NUCLEAR FUSION APPLICATIONS.

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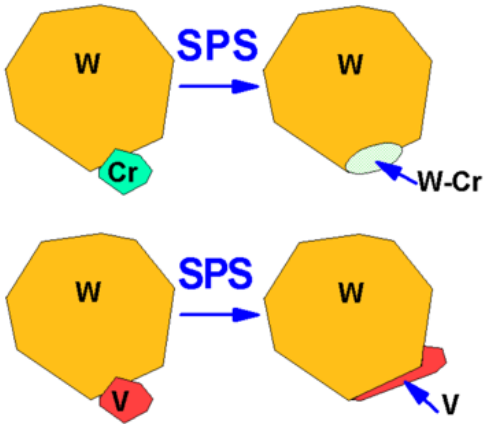
In fusion reactors' divertor, the most suited armor material is considered to be W, recommended by its high melting temperature, low T retention and high physical sputtering yield. Also, W has a rather high thermal conductivity, its only weaknesses being connected with poor mechanical properties at low temperatures and neutron irradiation embrittlement, especially after high temperature exposure. These properties are related to W initial microstructure and the grain growth in the recrystallized state, respectively. In this work we present results related to a possible improvement route of the W material, by including metallic dispersoids like Cr and V and producing consolidated samples by SPS (spark plasma sintering) followed by a high temperature thermo-mechanical treatment. While W-Cr and W-V phase diagrams suggest the formation of solid solutions, we have experimentally proven that choosing adequate grain dimensions for W and Cr or V it is possible to produce composites with preserved metallic dispersoids. Microstructural thermophysical and mechanical properties results are discussed.



Keywords: materials for fusion applications, Tungsten, thermophysical properties

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S1 P1

3D VARIABLE MAGNETIC FIELD GENERATOR

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Magnetic fields represent an increasingly emergent domain for applications in numerous scientific and industrial fields, from biology and medicine, to plasma physics and optics. More

recently, research on transitory vectorial fields gained further attention as tools for experimental investigation of materials, as well as control of different processes. In this work, we present the development of a three-dimensional variable magnetic field generator, able to produce a controllable vectorial field environment for laboratory studies. The field generation device consists of a multi-inductor system in a hexa-pole geometry with multiple electrical configuration options. Independent power amplifiers are used to source the field, while a multi-channel arbitrary waveform generation board enables independent and simultaneous control of the orthogonal magnetic field components along the three spatial coordinate axes (X, Y, Z) of the device. Using open-source software, custom drivers have been designed and implemented for controlling the generation process and performing dynamic modification of signal amplitude and phase in a wide frequency range. A cross-platform graphical interface was also developed using open-source software (Python libraries) for user control of waveform generation, as well as visualization of the magnetic field vector.

Using the 3D visualization tool of the graphical interface, we monitored generated signals in different geometries: from stationary to variable and from linear to planar, and, eventually, variable 3D fields. Simultaneously, output signals were recorded by a multi-channel oscilloscope. A comparison between the generated and experimentally recorded signals is presented and discussed with respect to the targeted applications. Future development perspectives are also included.

Keywords: variable magnetic field; waveform generator.

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S1 P2

EFFECT OF DEPOSITION SUBSTRATE ON THE PROPERTIES OF OXIDE/METAL/OXIDE MULTILAYER TRANSPARENT CONDUCTIVE ELECTRODES

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In the last years, oxide/metal/oxide (OMO) multilayer structures emerge as suitable alternatives to indium tin oxide (ITO) in transparent conductive electrode (TCE) applications. ITO, the most common TCE used in the fabrication of organic photovoltaic (OPV) cell or organic light emitting device (OLED), has some drawbacks related to its poor tolerance to mechanical stress and the depletion of the indium resources [1]. Among the various materials developed for overcoming ITO limitations OMO nanostructures have received much interest due to their high optical transparency (in thin film form) and low resistivity [2]. Thus, the present study is focused on the assessment of the properties of ZnO/Ag/ZnO structures deposited by radio frequency magnetron sputtering (ZnO) and thermal vacuum evaporation (Ag) on rigid glass and flexible polymeric substrates. In the OMO deposition were used flat and patterned substrates in order to evaluate the influence of pattern effect on the properties of ZnO/Ag/ZnO structures. The optical and electrical measurements reveal that the transmittance and the sheet resistance of the multilayer structures are strongly influenced by the ZnO thickness and the substrate type. The fabricated OMO multilayer transparent electrodes are featured by adequate thickness, optical and electrical properties for optoelectronic applications.

Keywords: multilayer transparent conductive electrodes, ZnO, flexible substrate, patterned substrate

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S1 P3

CARBON-ZINC OXIDE NANOCOMPOSITES FOR DYE-SENSITIZED SOLAR CELLS

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Carbon-zinc oxide (C-ZnO) composites can be used as photoanodes in dye-sensitized solar cells (DSSCs) to enhance their performance. By combining ZnO with a carbon material, the obtained composite can improve electron transport, reduce recombination, and increase the overall efficiency of the DSSC. Carbon materials can increase the surface area of the photoanode, leading to better dye adsorption and photocurrent generation, and also stabilize the ZnO photoanode and prevent the dye degradation over time. Thus the benefits of using C-ZnO composites in DSSCs are the improving of efficiency and the enhancing of their stability [1, 2]. is the hydrochar.

Hydrochar, a carbonaceous material that has gotten interesting in recent years, is a solid product of hydrothermal carbonization of biomass, which shows promise as a material in solar cell applications, particularly in enhancing the performance of solar absorbers. Its ability to facilitate electron transfer and absorb solar light, while also potentially reducing recombination of photogenerated electrons and holes, makes it a compelling candidate for various solar energy technologies [3].

We obtained and characterized C-ZnO nanocomposites starting from different carbon and respective carbonaceous materials. The ZnO nanopowders were chemical precipitated in suspensions obtained by sonification of carbon or carbonaceous materials (i.e., graphite, hydrochar, and coke), using different C:ZnO mass ratios (0.5 and 1% C). The hydrochar was obtained by hydrothermal carbonization of red cactus pears (*Opuntia* or "prickly pear cactus"). The obtained C-ZnO nanocomposites were characterized by XRD, UV-vis and FTIR spectroscopy, and used as semiconductors for DSSC photoanodes in order to identify the proper semiconductor for optimal performance of such devices. Anthocyanin natural dyes extracted from purple cabbage were employed as sensitizers for these photoanodes. The recorded data referring to the photovoltaic conversion efficiency, fill factor, short-circuit current, and open-circuit voltage show improved parameters for DSSCs based on C-ZnO in comparison with ZnO-based DSSCs.

Keywords: ZnO; carbonaceous materials; nanocomposites; DSSCs.

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S1 P4

CHEMICAL SYNTHESIS OF FeCo/Al2O3 NANOPOWDER FOR EMI SHIELDING APPLICATIONS

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Serious issues with electromagnetic interference have emerged as a result of the rapid advancement of information technology, particularly in the utilisation of electromagnetic waves in the GHz frequency range. Electromagnetic interference pollution can disrupt the operation of equipment and systems in the medical, industrial, commercial and military fields.

Electromagnetic waves with frequencies ranging from 30 to 300 GHz, is also potentially harmful to biological systems in the case of continuous and prolonged exposure to such radiation. Electromagnetic radiation (EMI) shielding materials, used to attenuate this unwanted electromagnetic energy, represent a significant problem, both for civilian and military purposes [1]. EMI shielding is achieved by reflecting and/or absorbing electromagnetic radiation by a material, which thus acts as a screen against the penetration of radiation [2]. In this regard is necessary to develop new composite structures that allow reducing, through absorption and/or reflection the level of radiation and improving the functioning of equipment and systems, by eliminating interference. The paper investigates the soft magnetic materials based on FeCo/Al_2O_3 core-shell nanoparticles, synthesized by sol-gel technique [3]. These nanomaterials combines the high saturation magnetisation of FeCo compound with the increased resistivity of Al_2O_3, properties that can be use for EMI shielding. The main physical characteristics of the Fe-Co/Al_2O_3 prepared nanopowders are: saturation magnetisation in the range of 100 - 165 emu/g, coercivity around 14.35 kA/m and resistivity in the range of 5,50 - 17,50 Ω·m [4]. The prepared FeCo/Al_2O_3 nanopowder will be use for development of composite materials for EMI shielding applications.

Keywords: chemical synthesis, nanopowder, soft magnetic, Fe-Co/Al_2O_3 nanoparticles

Acknowledgement: The financial support was provided by Ministry of Research, Innovation and Digitization, through contract PED No. 71/2025.

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S1 P5

EVALUATION OF HIGH FREQUENCY BEHAVIOR OF FeCo MAGNETIC, ELECTRICALLY INSULATED NANOPOWDERS

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The FeCo magnetic, electrically insulated nanopowders were prepared by chemical synthesis, starting from the salts of Fe, Co and Al [1]. The presence of Al_2O_3 with the FeCo compound generates a novel magnetic material with high magnetisation at saturation, low coercivity and increased resistivity. For example, the FeCo/Al_2O_3 microwave sintered materials reached values for the saturation magnetisation in the range of 136 to 213 emu/g (depending on the Al_2O_3 content), coercivity ~ 24.5 kA/m and electrical resistivities of order of 10^{14} Ω·m [2,3], proving an excellent efficiency for microwave absorption: an constant attenuation to the electromagnetic radiation, of ca. 50 dB in the frequency range of 0.3 to 4 GHz (see figure 1). All these characteristics recommend the new magnetic materials for high frequency applications. The paper presents the experimental research related to the synthesis of FeCo/Al_2O_3 nanopowders and the results of evaluation of their behavior on high frequency.

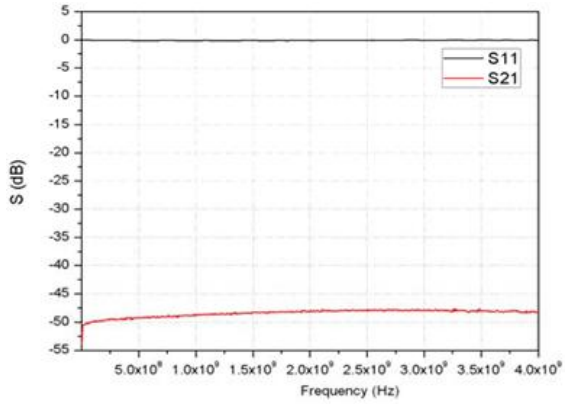

Fig. 1 Variation of reflection (S11) and transmission (S21) coefficients with frequency for microwave sintered FeCo/Al_2O_3, with 4% Al/(Fe+Co) molar ratio

Keywords: soft magnetic nanopowders, FeCo/Al_2O_3, chemical synthesis, high frequency behavior

Acknowledgement: The financial support was provided by Ministry of Research, Innovation and Digitization, through contract PED No. 71/2025.

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S1 P6

MULTI-SCALE APPROACH FOR SENSING BIOMARKERS WITH GRAPHENE-LIKE MATERIALS

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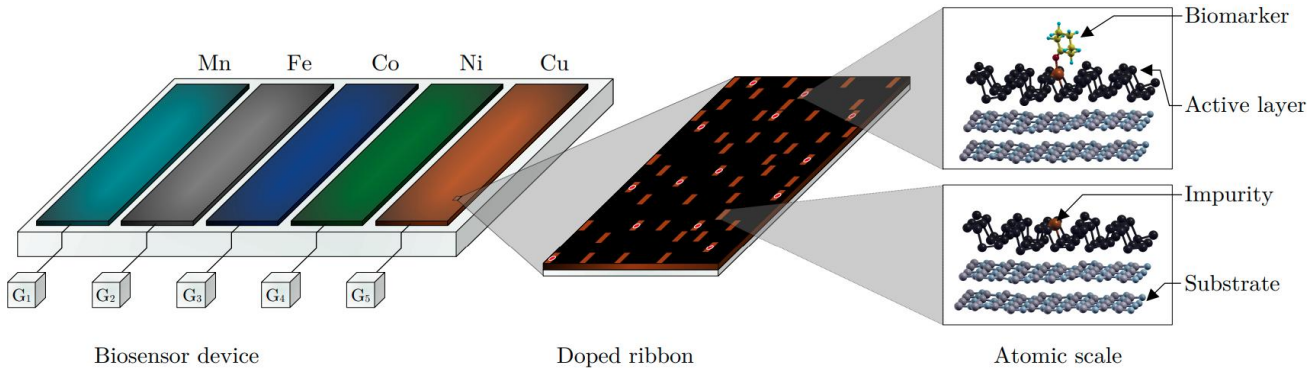
Accurate and rapid diagnosis of respiratory diseases is nowadays highly demanded. Pulmonary infections such as tuberculosis and influenza A are two of the many affections that untreated and undetected lead to serious health problems and even death. These are usually identified by specific biomarkers found in exhaled products.

By using the tunability of 2D materials such as black phosphorus (i.e. BP) the sensing of biomarkers can be optimized. In contrast to normal biosensors, where the results are found based on measuring a single observable, a pattern-based recognition approach yields better performance. Such a device was proposed in a previous study [1], where the detection was performed on a set of given conductances. In the current study, we propose an extension, namely a multi-scale approach, where the conductance of the macroscopic system is found from averaged carrier concentrations obtained from DFT simulations in atomic-sized subsystems. The configuration of the biomarkers (i.e. acetone and cyclohexanone) and of the primary air molecules are obtained from *ab initio* molecular dynamics (AIMD) simulations. In this context, we also investigated the possibility if optimizing the AIMD simulations with machine learning (ML) techniques. The final device is composed of several ribbon-like macroscopic systems each doped with different transition metals as shown in the figure. The concentration of the biomarker in the exhaled air is found by solving a linear system of equations using the test-case conductances, knowing the reference ones from the calibration-database.



Keywords: biosensor, multi-scale, density functional theory, molecular dynamics.

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S1 P7

STRUCTURAL PROPERTIES AND PERFORMANCE OF THIN-FILM NOBLE METALS

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We studied nanostructured gold ultra-thin films deposited onto the SiO_2 surface with thicknesses of 1 nm, 3 nm, 4 nm, 5 nm, 6 nm, and 10 nm. The radio-frequency magnetron sputtering technique had a significant effect on forming uniform and continuous gold films on the SiO_2 surface. After deposition, we investigated the surface topography of all thin films using high-resolution scanning electron microscopy (HRSEM). AFM, ellipsometry measurements, 2D maps, interferograms, profiles, and contact angle measurements were employed to characterize the surface properties of these films.

The changes in surface morphology showed that the surface roughness was significantly reduced. The analyzed XPS general scans and HRXPS scans confirmed the presence of Au $4f_5$ and Au $4f_7$ peaks in the gold nanostructures. XRD diffractograms indicated that the Au samples were crystalline. In these noble samples, the orientation was clearly aligned with the main planes perpendicular to the substrate for the (111) planes.

The Au/SiO_2 ultra-thin films exhibited good structural properties, highlighted by their crystallographic quality, as evidenced by XRD analysis, and high spectral transmission in the visible and infrared ranges. Therefore, the obtained noble metal ultra-thin films, with their controlled morphology, are suitable for use in future applications involving structures with metasurfaces or metamaterials.

Keywords: noble metals, thin films, structural properties, metamaterial structures.

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S1 P8

OPTICAL AND DIELECTRIC PROPERTIES OF TmF_3 DOPED FLUORITE CRYSTALS

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Rare-earth-doped fluorite crystals have garnered considerable attention due to their exceptional optical properties and diverse applications, particularly in laser technologies and scintillators. Among these materials, CaF_2 and BaF_2 crystals doped with TmF_3 exhibit remarkable luminescent characteristics, making them promising candidates for advanced optical systems [1-3].

This study focuses on the luminescent properties of Tm^{3+} and Tm^{2+} ions in fluorite crystals grown in our Crystal Growth Laboratory using the vertical Bridgman method. A comprehensive Judd–Ofelt analysis was performed on Tm^{3+}-doped crystals to evaluate their spectroscopic behavior and potential applications. The Judd–Ofelt theory provides a robust framework for interpreting optical transitions and calculating the spectroscopic parameters of rare-earth ions in crystalline matrices [4]. For the Tm^{3+}-doped crystals under investigation, the intensity parameters (Ω_2, Ω_4, and Ω_6) were determined, offering valuable insights into radiative properties such as emission cross-sections, branching ratios, and quantum efficiencies, which are critical for the development of advanced laser and optical devices.

Advances in spectroscopic techniques and theoretical modeling have significantly enhanced the understanding of energy transfer processes and relaxation dynamics in Tm^{3+}-doped fluorite crystals [4,5]. By integrating these advancements into the Judd–Ofelt framework, this research sheds light on the luminescence mechanisms and spectral features of Tm^{3+} ions, enabling their optimization for laser applications. Additionally, the impact of x-ray irradiation on the spectroscopic properties of the as-grown crystals will be examined to further elucidate their potential in cutting-edge optical technologies.

Keywords: calcium fluoride, thulium fluoride, J-O analysis, spectroscopic properties.

Acknowledgments: This work was supported by ESCARGOT project founded by the Romania's recovery and resilience plan, PNRR/2022/C9/MCID/I8.

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S1 P9

INVESTIGATION OF STRUCTURAL PROPERTIES OF Tb DOPED CaF_2 and BaF_2 CRYSTALS

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Fluoride-based MF_2 (M=Ca, Ba) materials are well known [1,2] due to their intrinsic properties, such as a high optical transparency (VUV–VIS–IR range), low phonon energy, small refractive index, remarkable physicochemical properties (non-hygroscopy in most cases) and ease of machining and polishing. In this work, Bridgman technique was used for the growth of CaF_2 and BaF_2 fluoride crystals doped with different concentrations of TbF_3.

The understanding of complex relationships between the optical properties, local symmetry of the dopant, and the host crystal structure (matrix) provides a better knowledge of the properties for these fluoride materials. CaF_2 and BaF_2 fluoride crystals doped with different concentrations (1, 5 and 10 mol%) TbF_3 were investigated by laboratory techniques (crushed single crystals and single crystals X-Ray diffraction) and by neutron diffraction.

The structural characteristics in function of the host material (CaF_2 or BaF_2) and with the increase in Tb doping concentration was analyzed. For these materials, the level of doping into the host lattice induces different behavior: tetragonal (C_{4v}), trigonal (C_{3v}) or cubic (O_h) for low values of doping and clusters for higher doping. The laboratory XRD and neutron investigations evidenced that the materials are single phase, allowed to determine unit cell constants and inter-atomic distances and confirmed the tendency of clusterisation with the doping increase.

Keywords: crystal structure, fluoride, doping, diffraction.

Acknowledgements: This work is supported by a grant PNRR/2022/C9/MCID/I8, project title "Enhanced Single Crystal Applications and Research in the Growth of new Optical rare earth-based compounds for sustainable and efficient Technologies (ESCARGOT), contact number 136/15.11.2022.

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S1 P10

SPECTROSCOPIC PROPERTIES OF FLUORIDE CRYSTALS (CaF_2, BaF_2) DOPED WITH Tb^{3+}

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Rare-earth RE^{3+} (Tb, Er, Tm etc.) ions-doped fluoride (CaF_2, BaF_2) crystals are of great interest due to the possible use in various applications [1]. Among the rare earths, terbium doped fluoride matrix have potential to be used in lasers with application in medicine or energy.

Fluorides crystalline matrix (CaF_2, BaF_2) have a cubic structure (Fm-3m space group), with the fluoride cations surrounded by eight F^- ions, while F^- atoms are enclosed by four Ca^{2+}/Ba^{2+} ions [2]. The RE^{3+} doping into the host lattice is made without change in the symmetry and the excess of charge is compensated by interstitial F^- ions in different positions leading to isolated site symmetry centers, at low dopant concentration like tetragonal (C_{4v}), trigonal (C_{3v}), cubic (O_h) or more complex clusters for higher doping [3-4]. These differences in site symmetries influence the optical characteristics used in applications.

Three concentrations (1, 5 and 10 mol %) of Tb^{3+}-doped fluoride (CaF_2, BaF_2) crystals where grown by using an in-house vertical Bridgman configuration. The study of the dislocations density using the chemical etching method was performed in order to characterize the crystal quality. Optical investigations by absorption and emission spectroscopy were carried out at room temperature in order to point out the influence of Tb content. Moreover, Judd–Ofelt (J–O) analysis was used to estimate the transition probabilities of Tb^{3+} ion.

Keywords: crystal growth, Tb^{3+} doping, optical properties.

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S1 P11

PHYSICAL-CHEMICAL CHARACTERIZATION OF NOVEL POLYSACCHARIDE-BASED GELS

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Polysaccharide hydrogels, which can be obtained from diverse natural sources such as plants or marine organisms and may have important medical applications, emerged as a hot research topic in recent years [1,2]. Among hydrogels, those based on nanocellulose (NC), a highly hydrophilic and renewable material, have been intensively studied due to the amassing advantages of NC gathered into relatively cheap and easy-to-obtain materials. NC hydrogels stand out due to their biocompatibility, biodegradability, nontoxicity, high water-holding capacity, good mechanical and tunable surface properties, and gelation ability [3]. Physical or chemical cross-linking is often used to improve the properties of hydrogels, such as their mechanical properties, stability, elasticity, or viscosity [4]. More than a single polysaccharide is generally used in the production of gels to improve gelation, gel stability, mechanical integrity, or to add new properties. Sulfated polysaccharides are notable for their various pharmacological effects, including antioxidant, antidiabetic, antitumor, immunomodulatory, hepatoprotective, and antiviral properties [5]. Fucoidan (F) is an important component of marine algae, which possesses the aforementioned properties but comes with certain deficiencies, such as a lack of gelation ability and weak stability under processing. Combining the

two polysaccharides, NC and F, in new polysaccharide hydrogel systems is considered an innovative route for designing new-generation biomaterials.

Polysaccharide hydrogel systems containing NC and F in various proportions were obtained using different additives and conditions. The new systems were characterized by rheological measurements, Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), and electronic microscopy. The above-mentioned measurements emphasized the effects of additives and preparation conditions on the viscosity, morpho-structural, and thermal properties, along with gelation ability.

Keywords: rheology, thermogravimetric analysis, microscopy, polysaccharides

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S1 P12

INNOVATIVE KRETSCHMANN SPR SENSOR FOR SUCROSE SENSING

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Surface plasmon resonance (SPR) based sensors have long been of interest due to the high sensitivity of their optical signal to the refractive index of analytes. The strong dependence of the SPR coupling condition on the dielectric properties of the materials involved leads to a reliable correlation between analyte refractive index and resonance wavelength[1]. Moreover, for small changes in analyte refractive index, the dependence of reflectance dip wavelength on refractive index is linear, making the calibration and analysis of such a sensor easy to implement.

The present work focuses on such a highly sensitive Kretschmann-configured SPR sensor, but in a more compact and easier-to-use configuration, designed for the detection of sucrose in aqueous solutions. Built entirely from scratch, the system uses, in terms of its main components, a 45 nm gold

film deposited on a thin glass slide (cover glass), an N-BK7 prism, a microfluidic system for analyte pumping, as well as a light source and spectrometer. Designed to operate at a fixed incidence angle of about 70°, the signal consists of a visible range reflectance spectrum for each analyte solution involved. In this context, the experimental tests were carried out using sucrose solutions of varying concentrations (0% to 12% w/w) with a known refractive index. The key feature for such a sensor is sensitivity, measured in nm per refractive index units. For this particular sensor, the sensitivity in the 1.33-1.36 refractive index range was about 4600 nm/RIU, which is comparable to other highly sensitive gold-based biosensors[2].

Its signal has also been modeled theoretically. Although the predicted sensitivity for the setup was significantly smaller, the film roughness, as well as other deviations from perfectly flat optical interfaces, are most likely the reason behind the increased sensitivity, while generating a slight widening of the reflectance dip. Because the sharpness of the dip was not significantly altered, this tradeoff is very useful, overall increasing sensitivity without compromising the signal quality.

Keywords: surface plasmon resonance (SPR), plasmonic sensors, numerical simulations, sucrose

Acknowledgments: This research was supported by the National Authority for Research and Innovation in the framework of the Nucleus Programme—LAPLAS VII (grant 30N/2023) and by the grants of the Ministry of Research, Innovation and Digitalization, CNCS/CCCDI- UEFISCDI, project no. 19PCE/2025, PN-IV-P1-PCE-2023-1902 and project no. 72/2024, ERANET-M-3-GasSensingMat-RT-1, within PNCDI IV and PoCIDIF nr. 390008/27.11.2024.

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S1 P13

THERMAL PROPERTIES AND MORPHOLOGICAL FEATURES OF NEW POLYSACCHARIDE-BASED SYSTEMS

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Natural polysaccharides, which may be obtained from a multitude of sources such as plants, algae, animals, and fungi, are widely used in medicine [1,2]. In recent years, natural polysaccharides have been intensively exploited for designing new generation drugs, characterized by anti-inflammatory, antitumor, antioxidant, and/or immune-regulating properties [3]. Systems containing more than one polysaccharide have captured researchers' attention due to the increased possibilities of adjusting their properties for the purposed application. Nanocellulose (NC), which is obtained from cellulose, a widespread and inexpensive polysaccharide, is a versatile material already used as

adsorbent for removing pollutants from wastewaters, carrier for the controlled release of drugs or fertilizers, reinforcing agent in biopolymer nanocomposites, or substrate for flexible sensors [4,5]. On the other hand, sulfated polysaccharides such as fucoidan (F) or carrageenan are highly bioactive products with anticoagulant, antitumor, hypolipidemic, immunomodulatory, hepatoprotective, and antiviral properties [6]. Combining nanocellulose with a sulfated polysaccharide may lead to new materials with unique properties. Therefore, in this work, new systems based on NC and F were studied with the aim of designing new generation bionanomaterials.

Natural polysaccharide systems based on NC and F in different ratios were prepared by several methods and the new materials were characterized by Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), viscosity measurements, and scanning electron microscopy (SEM). FTIR showed the characteristic patterns of the two components, the TGA and rheological measurements emphasized the great influence of the NC/F ratio on the thermal and viscous properties of the resulting formulations, while SEM allowed for the assessment of the degree of interaction/segregation between components.

Keywords: thermogravimetric analysis, scanning electron microscopy, polysaccharides, nanocellulose

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S1 P14

X-RAY INDUCED CHARGE CONVERION OF Tm IONS IN CaF_2:TmF_3 CRYSTALS

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Valence state manipulation in rare-earth doped fluoride crystals has emerged as a important topic in the development of advanced photonic materials, scintillators, and solid-state dosimeters [1]. Among these, the charge conversion between Tm^{3+} and Tm^{2+} under ionizing radiation is of particular interest due to the distinctive spectroscopic properties [2]. Previous studies have demonstrated the formation of Tm^{2+} centers in CaF_2 and related hosts under various irradiation conditions, yet a systematic understanding of how dopant concentration influences the dynamics, stability, and spectral signature of these centers remains limited [2,3].

This study investigates in detail the X-ray induced charge conversion from Tm^{3+} to Tm^{2+} in CaF_2:TmF_3 single crystals, focusing on three representative doping levels: 0.1, 1, and 5 mol%. The formation and evolution of Tm^{2+} centers were monitored using UV-VIS absorption spectroscopy before and after irradiation. Well-resolved absorption bands attributed to both Tm^{2+} ions and color centers respectively were observed in the spectral intervals 190-210 nm, 290–330 nm, 390–420 nm. At low doping (0.1 mol%), the absorption associated with Tm^{2+} centers increased during irradiation and remained stable over time. In the 1 mol% sample, the formation of Tm^{2+} was more pronounced, followed by a exponential decay process after irradiation. For the highest doping level (5 mol%), the Tm^{2+} bands reached saturation and persisting without significant degradation for at least 20 days post-irradiation. A kinetic analysis based on exponential fitting functions was employed to model the Tm^{2+} formation and relaxation processes, yielding good agreement with experimental data. These results confirm the reproducibility and consistency of the X-ray induced charge conversion and highlight the role of dopant concentration in modulating the charge state dynamics

Keywords: X-ray irradiation, Tm^{2+} centers, UV-VIS spectroscopy, CaF_2:Tm^{3+}

Acknowledgements: This work is supported by a grant PNRR/2022/C9/MCID/I8, project title "Enhanced Single Crystal Applications and Research in the Growth of new Optical rare earth-based compounds for sustainable and efficient Technologies (ESCARGOT), contact number 136/15.11.2022.

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S1 P15

PREDICTING HYDROGEN DIFFUSION ENERGIES AND PATHWAYS IN BORON USING DFT, POTENTIAL LANDSCAPES, AND STATISTICAL METHODS

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Understanding hydrogen behavior in plasma-facing materials is essential for the performance and stability of fusion reactors such as the International Thermonuclear Experimental Reactor (ITER). With a full tungsten reactor, boronization is used to improve plasma conditions by reducing impurity concentrations, as boron is proven to efficiently capture residual gases such as oxygen and nitrogen that would otherwise degrade plasma quality [1, 2, 3]. During plasma operation, plasma species bombard the boronized surface, leading to sputtering, erosion, and the redeposition of boron, tungsten, and hydrogen isotopes. These interactions result in the gradual buildup of boron-deuterium

and boron-tungsten composite layers, which play a critical role in impurity retention and plasma performance. There is a great need to study both elementary processes and the mechanical and thermal stability of boron layers, including erosion, re-deposition, dust formation, and nuclear fuel retention under ITER-relevant parameters. The retention and release properties of hydrogen isotopes in boron layers and structures are critical from both a theoretical and structural perspective, with these findings being directly correlated with experimental results. Thus, hydrogen isotopes diffusion is an important process in understanding and describing the retention and release characteristics of hydrogen from boron structures.

In this work, we present a new approach for studying hydrogen diffusion in boron using Density Functional Theory (DFT) and the SIESTA software, combined with a statistical treatment of the migration process. Based on DFT calculations, we construct the potential energy landscape experienced by hydrogen atoms within both crystalline and amorphous boron structures. Local minima, saddle points, and possible diffusion trajectories are identified directly from the calculated energy surfaces. To describe hydrogen trajectory, we apply a statistical model based on a Markov process, where transitions between local minima are governed by the energy barriers connecting them. The evolution of the system is treated through the Master equation, leading to the calculation of probability distributions for hydrogen positions over time. The statistical approach allows us to describe diffusion behavior by considering the influence of local energy variations. This approach allows the extraction of probability distributions for hydrogen migration paths and contributes to a better understanding of hydrogen retention and transport in co-deposited B-H layers.

Keywords: hydrogen diffusion, potential landscape, Master equation

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S1 P16

ADVANCED TUNGSTEN MATERIALS PRODUCED IN NIMP FOR DIVERTOR ARMOR APPLICATION IN THERMO-NUCLEAR FUSION REACTORS

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Research and development in both magnetic and inertial confinement fusion has achieved an increased maturity with a consistent progress in the last years. Taking into account that obtaining energy from fusion reactions might be the only long-term sustainable solution for the increasing world energy demand, the design and development of suited materials became a goal for international research and industry. In a magnetic confinement fusion reactor the plasma used to generate nuclear reactions will reach temperatures of the 100 million degrees order. Although this plasma should not be in direct contact with the reactor walls, a large amount of heat generated by electromagnetic radiation, electrons and ions being expelled from the plasma will reach the plasma-facing surface of the reactor. Thus, plasma-facing materials should be able to withstand temperatures in normal operating conditions of about 1000 C and, in particular situations, even over 2500 C. This large

amount of heat should be efficiently transferred to the cooling system, implying also a high thermal conductivity. Of course, these materials must contains only low-activation elements, restricting the number of acceptable materials to only a few elements. Tungsten (W) was selected as the main divertor armor material for ITER and is the "base-line" option for DEMO (which will be the first demonstrative reactor able to provide energy to the grid). However, in this case higher temperatures and irradiation doses are foreseen, which demand better materials. In this work we present the development of such W-based materials, produced in NIMP in the frame of EUROfusion consortium.

Keywords: materials for fusion applications, Tungsten

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ABSTRACTS

S2 – Laser, Plasma and Radiation Physics and Applications

- *Laser Physics and applications*
- *Plasma Physics and applications*
- *Optoelectronics and photonics*
- *Applied and non-linear optics*
- *Ultrafast phenomena and applications*

S2 L1

APPLICATION OF A DOUBLE HEATED PROBE FOR (L)TVA PLASMA DIAGNOSTIC

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When measuring with a Langmuir probe in a TVA system the layer intended to be deposited onto the substrate is deposited also onto the probe and its holder. Consequently, we constructed the probe in form of a wire loop that was heated by dc current up to approximately 1000 °C (red heat). The tungsten wire loop heated simultaneously the ceramic probe support thus preventing layer deposition also on its surface.

The plasma diagnostic system as well as the probe data analysis was like that described in [1]; however, two probes were used instead of one in the arrangement of a double probe. Such a system minimizes the effect of the plasma instabilities that deform the single probe data. Both heated probes were made of a loop of thoriated tungsten wire of 0.15 mm diameter with a length ~ 10 mm. Both probes were placed close to the crucible. The circuit for the double probe characteristic acquisition was floating as well as the power supplies for the heating of the probes. The heated probe measurements were performed simultaneously with deposition of the used materials (Mg, mixture of Zn and Al) onto the substrates.

From the recorded double probe characteristic data, we estimated the two basic plasma parameters: the electron density N_e and the electron temperature T_e. The plasma potential V_{pl} was estimated from the floating potential V_{fl} and the measured electron temperature by the formula $V_{pl} \approx V_{fl} + T_e ln\sqrt{m_i/m_e}$. Since the double probe arrangement removed problems with the plasma oscillations, the probe data was sufficiently smooth, and it was possible to calculate $I_e'' = \mathrm{d}^2 I_e / \mathrm{d}U_p^2$ connected with the electron energy distribution function (EEDF) $F(\varepsilon)$ [2]: $F(\varepsilon) = \frac{4}{q_0^3 N_e A_p}\left(\frac{m_e}{2}\right)^{1/2} \varepsilon^{1/2} \frac{\mathrm{d}^2 I_e}{\mathrm{d}U_p^2}$, $\varepsilon = q_0 U_p$. The measured EEDF deviated, as a rule in the higher-energy part (tail), from Maxwellian; it resembled the known "double temperature" form, see Fig. 1. The percentage of electrons in the EEDF having energy greater than ~2.8 eV estimated by the method described in [**Eroare! Marcaj în document nedefinit.**] did not t ypically exceed units of percent.

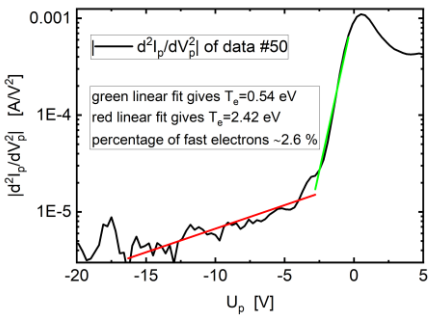

Fig 1. Two linear fits of the second derivative of the data set #50. Two slopes correspond to two electron temperatures for electrons in the energy range -0.4 ÷ -2.8 eV (green line, 0.54 eV) and -2.8 ÷ -16,3 eV (red line, 2.42 eV).

Keywords: double heated probe, TVA, LTVA, "double-temperature" EEDF

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S2 L2

MAGNESIUM-BASED NANOCOMPOSITES OBTAINED BY IMPLEMENTING AN INNOVATIVE CONCEPT OF LASER-PLASMA TECHNOLOGY FOR PROTECTIVE COATINGS IN INDUSTRIAL APPLICATIONS

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Nanocomposite materials started to be real dimensions for coating the components on production line. The binary combination presented in this work will refer to Mg:X (X=Zn, Al), deposited by the innovative Laser Induced-Thermionic Vacuum Arc LTVA method. Specifically, magnesium-based nanocomposites due to their remarkable surface coating properties without a significant reduction in the ductility typically associated with the addition of micron-sized reinforcements, make them an attractive choice for lightweight structural applications. Recently, the studies proved that the dependence of the behavior on the particle sizes can allow one to engineer their properties.

Multi-component thin films as well as single thin films were deposited using Laser induced Thermionic Vacuum Arc (LTVA) technology. The deposited thin films were characterized by means of a using scanning electron microscope (SEM) accompanied energy-dispersive X-ray spectroscopy (EDX). The wettability of the deposited Mg:X thin films was investigated by the surface free energy evaluation (SFE) method. The purpose of our study was to prove the potential applications of Mg-based thin films in various fields, including batteries, coatings, solar collectors, and materials science.

Keywords: Laser Induced-Thermionic Vacuum Arc (LTVA); Magnesium based thin films.

Acknowledgment: This work was partially supported by the Core Program of Romanian Ministry of Research, Innovation, and Digitalization through Projects PC2-PN23080202.

S2 L3

DIFFERENT APPROACHES IN HIGH-TEMPERATURE TRIBOLOGICAL TESTING OF HARD COATINGS

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Ternary TiAlN hard coatings are extensively used in various fields, with cutting applications being one of the primary uses. These coatings are characterized by their high hardness and oxidation resistance [1]. However, their tribological performance is equally important. In order to simulate real working conditions, the tribological behavior of the coatings has to be investigated at high temperatures. However, another way to simplify these investigations is to perform heat treatment (annealing) of the coated samples and after the samples cool down perform tribological examination. These two testing methods resulted in significantly different results. Therefore, the motivation for this study was to highlight the difference between these two approaches.

This study investigated TiAlN coating deposited by industrial cathodic arc deposition unit on hot-work tool steel substrate (EN X38CrMoV5). The coating's hardness was determined by nanoindentation and was approximately 3000 $HV_{0.05}$, while thickness of the coating was 3 μm. The tribological behavior of the coating was assessed using a high-temperature tribometer equipped with Al_2O_3 ball, in ambient air. Tribological tests were performed at room temperature (RT), 300 °C, 500 °C, 600 °C, 700 °C, while the other samples were initially exposed to these temperatures (annealed) and underwent tribological testing at RT after they cooled down. The produced wear tracks were then analyzed by stylus profilometry, confocal microscopy, focused ion beam, and scanning electron microscopy equipped with energy dispersive spectroscopy. In room temperature tests, the steady-state coefficient of friction (COF) was approximately 0.7. On the other hand, at high temperature the COF significantly varied depending on the testing temperature. At 300 °C and 500 °C the COF values constantly increased, while at 600 °C and 700 °C the COF values reached a local maximum after which it declined. Each tribo-test of the annealed samples produced COF values similar to tribo-tests at room temperature, apart from the strong osscilations. The tests at RT and for annealed samples were characterized with abrasive and adhesive wear mechanism, while at high temperatures abrasive and oxidative wear mechanisms were observed. Additionally, at 600 and 700 °C oxidation of substrate was observed, which resulted in formation of Fe-O and Cr-O inside the wear track. This destroyed the coating inside the wear track, and was the reason for decrease of COF at these temperatures. Finally, it was concluded that the tribological test results for annealed samples are quite different from those performed directly at high temperatures. The friction coefficients, wear rates and wear mechanisms in these tests are similar to those seen in room temperature tests.

Keywords: PVD, Tribology, High-temperature, TiAlN, Oxidation.

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S2 L4

NOVEL CURLING PROBE FOR ELECTRON DENSITY MEASUREMENT IN LOW-PRESSURE HOT TUNGSTEN CATHODE SYSTEM

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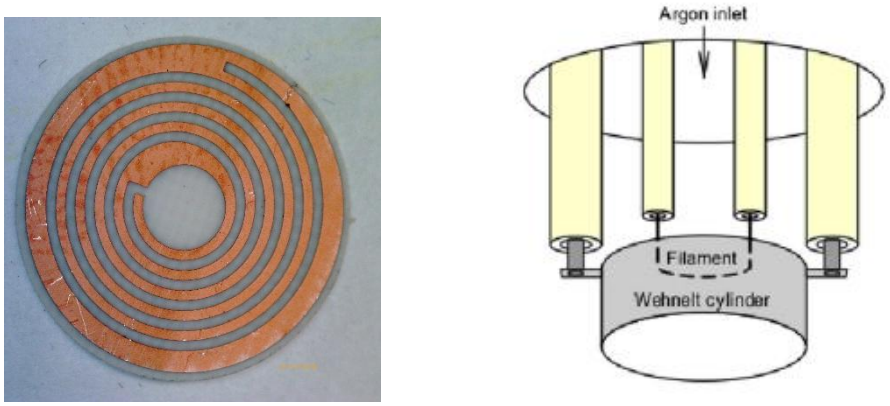
Active Plasma Resonance Spectroscopy (APRS) [1] refers to a class of diagnostic techniques that exploit the intrinsic ability of plasmas to resonate at or near the electron plasma frequency. In this technique, a radio-frequency signal typically in the gigahertz range is coupled into the plasma chamber via an antenna or probe, the spectral response is measured, and an analytical equation is applied to extract key plasma parameters, such as electron density [2]. The Curling probe, a recent innovation by Sugai et al. [3], represents a novel implementation of APRS offering several practical

advantages. It consists of a planar high-frequency resonator, realized as a conductive spiral printed on a dielectric substrate. The probe operates on the principle that changes in the surrounding permittivity shift its resonant frequency. When immersed in plasma, this shift can be analyzed to determine the local permittivity and, consequently, the plasma density. The Curling probe's compact design allows for miniaturization and seamless integration into chamber walls, enabling non-intrusive monitoring and potential control of plasma processes. Nevertheless, the range of detectable plasma densities is limited by the probe's design resonant frequency. This study presents the design and experimental characterization of a Curling probe shown in fig1 (a) in a hot tungsten cathode plasma system [4] in low pressure regime as shown in fig.1 (b).



(a) (b)

Fig.1 (a) Curling probe spiral, (b) Schematic of the hot tungsten cathode plasma system. Argon was injected through the top of a hot tungsten cathode system.

These measurements are conducted in argon gas at a low pressure of 1.5 Pa, with electron density evaluated as a function of discharge current. The results are subsequently compared with those obtained using a Langmuir probe for validation.

Keywords: Active Plasma Resonance Spectroscopy, Curling probe, Langmuir probe, DC discharge

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S2 L5

NON-THERMAL PLASMA – A TOOL FOR PEST CONTROL IN AGRICULTURE

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The talk is intended as an overview of literature results on the potential use of non-thermal plasma for insect pests' management. The influence of various factors on insect mortality will be discussed, among them the plasma parameters, the treatment time, the gaseous atmosphere, the time post-treatment when the evaluation is made, etc. It is generally accepted that higher treatment intensity, meaning larger discharge power and/or longer exposure time, reduces insects' survival [1,2]. Obviously, mortality also depends on the species and life-stage of insects [2,3]. Studies containing more detailed monitoring of insects exposed to plasma throughout their lifetime will be mentioned in the talk, revealing morphological anomalies [4,5], functional/ behavioral changes [3,5,6], as well as detrimental effects on the reproductive capability of treated adults or adults emerging from treated larvae or pupae [7,8]. Findings regarding the response to stress of insects subjected to electrical discharges will be discussed as well, based on the data reported from biochemical tests determining enzymes with antioxidant activity [4,6,9]. When treating pests infesting stored products, plasma exposure may at the same time affect the quality of treated agricultural products. Literature studies considering these effects will be indicated, emphasizing that the treatment should be tuned to avoid damage of the treated products [2,10].

The promising results revealed by this literature analysis recommends non-thermal plasma as an interesting approach to reduce or even eliminate insect pests, as it is effective, environmentally-friendly, leaving no harmful residues, and non-damaging to agricultural products, when applied in relatively low doses. However, further research into the mechanisms responsible for the biological effects of plasma on insects is certainly needed. More efforts are required to correlate plasma characteristics with the induced impact, thus allowing identification of the essential contributors to the insecticidal effect, which would open the way to tailoring discharge parameters for increased efficiency.

Keywords: non-thermal plasma, insect pest control.

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S2 L6

OPTICAL EMISSION SPECTROSCOPY OF PULSED ELECTRON BEAM PLASMAS

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Pulsed electron beam deposition (PED) is a versatile technique for the growth of oxide thin films with tailorable optical and electrical properties for applications in transparent electronics, photovoltaics and photocatalysis [1]. PED has few similar features to the pulsed laser deposition method: the pulsed nature of the process, the anisotropic dynamics of the ablation plasma plume, and energetic species contributing to the film growth. The study of the angular dependence of ablation plasma species and film thickness profile as a function of the angle showed that the film composition slightly differs over a wide angular range with respect to the ablated oxide target [2].

The time and spatial evolution of chemical species in the ablation plasma plume generated by the interaction of a pulsed electron beam with a metallic or oxide target was comparatively investigated by optical emission spectroscopy. In both cases, the electron temperature and density showed a time evolution depending on the re-excitation phenomena during the plasma plume expansion between the target and substrate.The mechanisms related to the ablation plasma dynamics as well as the transfer of the elemental distribution of an oxide target in the composition of a thin film will be presented and discussed. The mass of elements in the target and background gas play an essential role in plasma dynamics and in determining the angular thickness and compositional profiles of the films.

Keywords: optical emission spectroscopy; plasma; pulsed electron beam deposition; thin films.

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S2 L7

THIN FILMS AND COATINGS SYNTHESIS BY THERMIONIC VACUUM ARC

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High temperature resistant, low friction, hard thin films/coatings were accomplished in order to enhance the substrate properties using the original thermionic vacuum arc method developed at National Institute for Laser, Plasma and Radiation Physics (INFLPR) [1-2]. The method uses an external source of electrons for the creation of metal vapours and ions. Its main property of controlling

the ions energy during deposition makes the TVA method very attractive for obtaining coatings of specific properties. Moreover, the possibility to deposit different materials sequential or simultaneously from multiple targets offers the advantage of obtaining composite thin films/coatings like the ones investigated in our laboratory C-Ni, Ni-Cr, Re-Cr-Ni, W-Cr-Fe, etc,

Since there are many processes involved into this plasma deposition method, we performed investigations for a better understanding of the involved phenomena and process optimization. The nano-structure, morphology, and mechanical properties of the prepared films/coatings were characterized using RAMAN spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), low angle X-ray diffraction (XRD), atomic force microscopy (AFM), micro and nano-hardness and tribological tests.

Given the experience accumulated and the success achieved in making multifunctional composite deposits, we address the subject of technological transfer from INFLPR and its implementation to the private company (MGM STAR CONSTRUCT SRL).

Keywords: thermionic vacuum arc (TVA), thin films, coatings, plasma physics.

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S2 L8

BORON COATINGS FOR FUSION RELEVANT STUDIES. PLASMA PARAMETERS vs. FILM PROPERTIES

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The performance, safety, and longevity of ITER's magnetic confinement critically depend on how hydrogen isotopes behave in relation to the plasma-facing components. As a full-tungsten reactor environment is now desired, boronization is essential for reducing impurity levels [1]. This is because boron efficiently captures residual gases like oxygen and nitrogen, thereby enhancing plasma purity and improving overall plasma stability. However, continuous plasma exposure constantly modifies the boronized surface through the sputtering, erosion, and redeposition of boron, tungsten, and hydrogen isotopes. These dynamic interactions result in the formation of boron-tungsten and boron-deuterium co-deposited layers, which play a crucial role in impurity retention, hydrogen storage, and long-term wall conditioning in fusion devices. Consequently, there is significant interest in studying these materials with respect to relevant ITER re-deposition and operation, as well as their retention and release behavior.

In this study, different physical vapor deposition (PVD) techniques, including Thermionic Vacuum Arc (TVA), RF magnetron sputtering, High Power Impulse Magnetron Sputtering (HiPIMS), and bipolar HiPIMS (BP-HiPIMS) were used to deposit boron films. During the

magnetron-based depositions, ion flux and ion energy were analyzed as functions of the applied power and the Ar/D_2 gas ratio. The obtained boron and boron-deuterium co-deposited layers were systematically characterized with regard to their structural properties, compound formation, and deuterium retention and release behavior. In addition, deuterium release temperatures and quantifying the total retained deuterium were another objective of these investigations. This study aim to correlate deposition conditions with film properties and to investigate the retention and release of hydrogen isotopes in relation with these parameters from boron structures.

Keywords: boron, coatings, nuclear fuel, plasma parameters

Acknowledgement: This work was supported by a grant of the Romanian Ministry of Education and research, CNCS-UEFISCDI, project number PN-IV-P2-2.1-TE-2023-1140, within PNCDI IV

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S2 L9

STRATEGIES FOR TUNING THE HIPIMS DEPOSITION PROCESS-APPLICATION FOR THICK DLC COATINGS ON METAL SUBSTRATES

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HiPIMS (High Power Impulse Magnetron Sputtering) has emerged as a variant of the magnetron sputtering technique, being characterized by a higher ionization degree and corresponding higher ion fluxes to the substrate [1]. This feature adds significant benefits for the quality of the deposited thin films, providing increased adhesion, higher density, better mechanical, electrical or optical properties. The use of pulsed regime provides an increased overall control of the film properties, enabling the use of additional control parameters such as peak power, repetition frequency, pulse duration, synchronized substrate biasing etc.

From the application perspective, the combination of properties and unique features of DLC (diamond like carbon) coatings makes them an interesting candidate. Their many advantages, such as high hardness, low friction coefficient, chemical inertness etc, comes with the challenges regarding their adhesion on the substrate, due to usually high levels of compressive stress. Moreover, the sputtering of carbon is a particularly challenging task [2], due to the relatively low ionization degree, low sputtering rate and the occurrence of micro arcs under high power regimes [3].

This contribution provides strategies for the development of HIPIMS process adapted for the deposition of DLC coatings by sputtering of a graphite target. The development is focused on the increase of peak current and corresponding ionized flux to the substrate. This task is performed by tuning some key parameters of the discharge, each dedicated to control one or more issues related to carbon sputtering. In that respect, peak voltage was used to finely tune the power input to the target and the sputtering regime, pulse duration was used to reduce the number of arc events and increase

the maximum peak power achieved under stable conditions, gas composition (Ar/Ne/C_2H_2 mixtures) was used to increase the electron temperature, the ionization degree and correspondingly the maximum current. The DLC coatings in the micrometer thickness range were deposited both on Si and on 304L steel substrates. The adhesion of the coatings to metallic substrate was ensured by using a thin Ti interlayer. Some key parameters that characterize the properties of the coatings are: nanoindentation hardness adjustable in the range from 15 to 30 GPa, friction coefficient under dry environment around 0.01, wear rates tested against sapphire ball in the range of 0.5-1 x 10-6 $mm^3N^{-1}m^{-1}$

Keywords: HiPIMS, DLC, coatings, mechanical properties

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S2 O1

CONICAL COIL FOCUSING OF A PROTON BEAM ACCELEREATD VIA HIGH POWER LASER-SOLID TARGET INTERACTIONS

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Recent advances in laser-plasma acceleration have opened new avenues for the generation of high-energy proton beams using compact laser setups [1]. In this work we present a novel method for focusing proton beams accelerated in the plasma produced at the interaction of high-power, short-pulse lasers with solid targets. The interaction leads to the formation of ultra-intense electric fields via mechanisms such as Target Normal Sheath Acceleration (TNSA), resulting in the emission of a broad-spectrum proton beam [2,3]. Due to the beam's inherent large divergence and energy spread, effective focusing and transport are crucial for potential applications in science, medicine, and industry.

We investigate an active focusing technique that utilizes a high-current conical solenoid to tailor the confining magnetic fields for laser-accelerated proton beams. This conical coil is complemented by a coaxial cylindrical solenoid to enhance focusing performance. To assess the feasibility of the approach, we perform particle-tracking simulations using a proton beam with parameters representative of typical experimental conditions—namely, a broad angular divergence of about 20

degrees and an energy spectrum ranging from a few MeV up to 20 MeV. The simulations allow us to analyze the beam's phase space and optimize the focusing configuration. Furthermore, we evaluate the dose deposition profile of the focused beam in a millimeter-scale water phantom, representative of a tumor, to explore its potential for biomedical applications.

These methods offer valuable insights into beam shaping strategies that improve collimation and energy selection, advancing laser-driven proton acceleration toward practical implementation in radiotherapy.

Keywords: proton beam, high-power laser, laser-plasma, dose deposition.

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S2 O2

ZINC OXIDE NANOWIRE LAYERS FOR LASER PARTICLE ACCELERATION PROCESSES

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Particle acceleration using high-power lasers is becoming a more reliable alternative to classical particle accelerators. The laser acceleration process is based on the beam interaction with the target and the efficiency of the process is strongly correlated with energy absorption into the target. Among many tested targets, solid targets with a nanostructured surface have been shown to enhance this energy absorption process. ZnO material on the other hand, has one of the largest families of nanostructure morphologies among all materials [1] and consequently, a wide range of applications, including targets for laser particle acceleration. The advantage of using such nanostructure layers is based on their high surface to volume ratio as well as potential alignment of these structures.

In the present study, using a bottom-up approach, ZnO nanowires have been grown on different substrates from laser ablation plasma, through the Vapor-Liquid-Solid mechanism. Substrate temperature and laser power, as well as substrate stoichiometry, were used to control nanowire morphology, obtaining different cross sections, sizes and orientations. Nanowires with lengths up to micrometers and with diameters from tens to hundreds of nanometers were grown. By choosing a substrate with a small crystal lattice mismatch with ZnO, better nanowire alignment was also obtained.

Light absorption simulations on such ZnO nanowires layers highlighted absorption in the 300-800 nm range and a low reflection. Therefore, they are expected to improve beam energy absorption

into the target and increase particle acceleration process efficiency, by using High-Power lasers (in our case Ti:Sapphire with a corresponding wavelength centered around 800 nm).

Keywords: ZnO, Nanowires, VLS-PLD

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S2 O3

EFFECTS OF CATHODE SPHERICITY ON PLASMA CHARACTERISTICS AND SPACE-CHARGE CONFIGURATIONS

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This study explores the plasma behaviour in a concentric spherical hollow cathode discharge by optical emission spectroscopy, with particular attention to the formation of complex structures, such as fireball-like regions emerging from a spherical single-orifice cathode. By mapping the spatial distribution of electron temperature and density, the research offers valuable insight into space-charge dynamics and the evolution of plasma structures. Spectral analysis of the emitted light supports these measurements, highlighting key characteristics of the electron population and plasma environment. Since conditions where excitation processes are primarily driven by electron impacts and the plasma deviates from local thermodynamic equilibrium (LTE), in such cases the Boltzmann plot method may not yield reliable results for determining the electron temperature. To address this, we employ a collisional-radiative model (CRM), which provides a more robust and suitable alternative under our experimental conditions. The diagnostic workflow includes automated spectral data processing with user-defined input and output directories. Reference data for argon emission lines, including wavelength, transition probabilities, statistical weights, energy levels, and Stark broadening parameters are imported from the NIST database. Experimental spectra are analysed to identify intensity peaks, with low-intensity signals filtered via a relative threshold to reduce noise. Detected peaks are then matched against reference wavelengths within a ±2 nm tolerance. For each matched line, the corresponding spectral parameters are extracted and stored for further analysis.

The results enhance understanding of plasma dispersion in cathode-based systems and highlight the configuration's potential as an effective ion acceleration source for advanced technological applications.

Keywords: Optical Emission Spectroscopy, Thrusters, Collisional-radiative model.

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S2 P1

CHARACTERISATION OF MAGNESIUM-BARIUM HEXAFERRITE THIN FILMS OBTAINED WITH TVA METOD

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Barium hexaferrite powder $BaFe_{12}O_{19}$ (BFO) is used for increasing the magnetic properties of materials. Previous deposition of BFO has many drawbacks. BFO was used in the past using matrix-assisted pulsed laser evaporation method. The substitution of Mg^{2+} cations that affects the distribution of Fe^{3+} in the lattice. The incorporation of BFO in cations increases the saturation magnetization and increase in coercivity. [1]

TVA is an innovative technique for depositing high-purity, densely structured, and exceptionally smooth thin films, making it ideal for synthesizing nanostructured materials. Some notable advantages of the TVA method include the fact that the growing thin film is bombarded throughout the deposition process with ions of the depositing material under high vacuum conditions. Additionally, a key benefit is that the energy of these bombarding ions can be precisely controlled and adjusted during deposition.

The deposited thin films were characterized by means of a using scanning electron microscope (SEM) accompanied energy-dispersive X-ray spectroscopy (EDX). The wettability of the deposited Mg:BFO thin films was investigated by the surface free energy evaluation (SFE) method. The results shows a contact angle of 117^o and a free surface energy of 5.44 mJ/m^2 based on the Wu-Equation of State model.

Keywords: $BaFe_{12}O_{19}$; Magnesium; TVA, thin-films.

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S2 P2

TiO_2/VO_2 NANOCOMPOSITES SYNTHESIZED BY LASER PYROLYSIS FOR SENSOR APPLICATIONS

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This work presents the preparation of TiO_2/VO_2 nanopowders by laser pyrolysis of volatile $TiCl_4$ and $VOCl_3$ precursors in the presence of air as oxidant and ethylene as sensitizer. Due to its superior chemical and physical characteristics, TiO_2 is the most significant component, while when doped/coupled or loaded with noble metals, the surface area and defect density are expected to be higher than in the bulk material, contributing to increased sensing activity. For this reason, TiO_2/VO_2 nanocomposites with different V concentrations (0.5-19.51 at.%), as well as pure VO_2 and TiO_2 samples, considered as reference samples, were obtained. The TiO_2/VO_2 nanopowders were characterized by complementary techniques. The structural results show the presence of both TiO_2 main phases: anatase - the majority one and rutile, as well as of small amounts of VO_2 phase in the case of the sample with the highest vanadium concentration, all those with small crystallite sizes. The sensing properties of the nanopowders were tested as nanocomposite layers of SAW (Surface Acoustic Wave) sensors, at different concentrations of CH_4. For the nanocomposite layers, PEI (polyethyleneimine) polymer and each type of nanopowders synthetized were deposited by spin coating on the sensor surface. These morphological and compositional modifications upon vanadium addition led to enhance of the TiO2 **sensitivity properties** for a novel CH_4 gas **sensor**.

Keywords: laser pyrolysis, V-doped TiO_2, surface acoustic wave sensor, methane

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S2 P3

THERAPEUTIC POTENTIAL OF LASER PYROLYSIS SYNTHESISED IRON OXIDE NANOCARIERS LOADED WITH DACARBAZINE

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Iron oxide nanoparticles with a mean size that falls under 8 nm have unique properties for biomedical applications due to their features, such as superparamagnetic properties, excellent biocompatibility combined with cellular internalization. Laser pyrolysis is a versatile method for iron oxide nanoparticle synthesis that comes with several advantages, including, but not limited to the purity of the final particles, control over the size range, relatively high yield. Moreover, nanoparticles synthesized by this method exhibit additional properties - high saturation magnetization (up to 70 emu/g), superficial functional groups, externally NPs size control (from 2 nm to 15 nm), and a narrow size distribution.

Since the method is based on the interaction between a CO_2 laser and a gas mixture, special consideration needs to be given regarding the precursor and sensitizer gases. This study investigates the synthesis of iron oxide nanoparticles using iron petacarbonyl and ethanol vapors as precursor/sensitizer gases. The novelty regarding the sensitizer is given by ethanol vapors which were observed to enhance the hydrophilicity and functionalization features of the obtained NPs as compared to conventional sensitizers (ethylene, SF6) due to its lower energy absorption. Regarding their morpho-structural characteristics, the obtained nanoparticles were investigated by XRD, SEM-EDX, TEM, XPS and magnetic potential at room temperature. For their potential clinical applications, these nanoparticles were stabilized with dextran, conjugated dacarbazine and exposed to human breast epithelial (MCF-12A) and breast cancer (MCF-7) cell lines in order to investigate their antitumor activity.

The data suggests that the nanocarrier exhibits a selective anti-proliferative effect and induces oxidative stress in breast cancer cells, highlighting its potential as a candidate for targeted breast cancer therapy.

Keywords: iron oxide nanoparticles, laser pyrolysis, breast cancer therapy,

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S2 P4

BINARY HAFNIUM OXIDES AND ZIRCONIUM THIN FILMS WITH SELF-CLEANING PROPERTIES DEPOSITED USING LOW PRESSURE TVA PLASMA DEPOSITION

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The binary configuration in this setup refers to the concurrent use of ZrO2 and HfO2, deposited using the innovative TVA (Thermionic Vacuum Arc) method. Specifically, the metallic oxides in question have been known for their high corrosion and temperature resistance, and furthermore have self-cleaning properties related to their intrinsic antistatic and hydrophobic properties. [1] These properties can also be further improved depending on the nanostructures formed on the surface, which can affect the dust-repellency properties, as well as hydrophobicity.

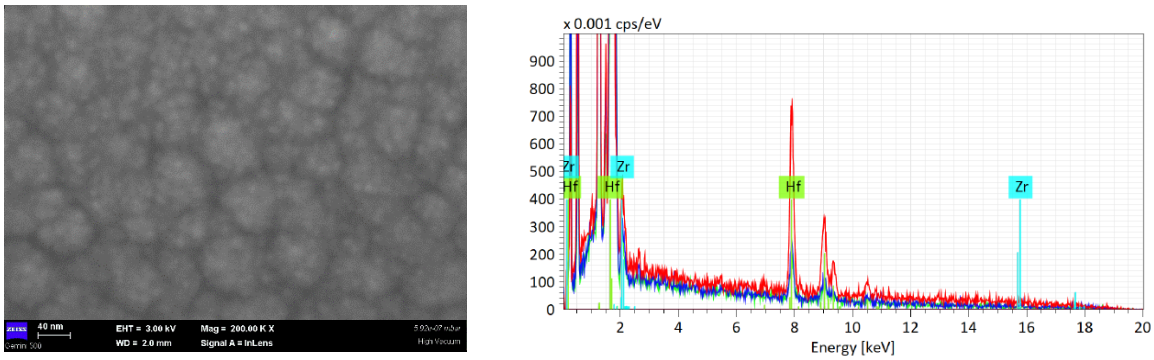

Figure 1. SEM image at 40 nm scale and EDX patterns of the obtained film.

The thin films in this binary format were deposited by one electron gun configuration and the results were very interesting regarding the structure of the film. The morphology of the deposited thin films (around 100 nm) on Si/SiO_2 substrates reveal an amorphous alloy with two large peaks at 28° and 41°. The Scanning Electron Microscopy (SEM) has shown a uniform distribution with rare crystallites on the surface. The Energy Dispersive X-ray (EDX), measured in at least three points suggest a uniform distribution for the Hf and Zr and the allover concentration (as a mean value) is Zr 20% and Hf 80%.

Keywords: Thermionic Vacuum Arc (TVA); Hafnium Oxide and Zirconium, thin films.

Acknowledgment This work was partially supported by the Core Program of Romanian Ministry of Research, Innovation, and Digitalization through Projects PC2-PN23080202.

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S2 P5

ETHYLENE EVOLUTION ON PERSIMMON FRUIT DURING SELF-LIFE

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Persimmon stands as one of the most favored fruits globally, holding a prominent position in international horticultural trade due to its profitable and marketable characteristics. It is considered an important agricultural product owing to its pleasant and unique taste, and excellent nutritional value for human well-being. Nevertheless, substantial losses occur due to inadequate harvesting, handling, storage, transportation, and marketing practices. As a representative example of climacteric fruit, persimmon undergoes substantial and irreversible changes in physiology, biochemistry, and sensory properties during ripening and storage. Advanced studies on tropical fruits physiology are extremely important to understand the mechanisms and the influences related to the ripening process and thus optimise the conditions for storage and transport, reducing this way the commercialisation losses.

In fruit, ethylene is emitted naturally in the process of ripening or may be produced when plants are injured in some way. This phytohormone is synthesized in great quantities during the late ripening stage and is involved in a wide range of processes, including fruit ripening, abscission, senescence and responses to biotic and abiotic stresses.

In an effort to understand the exact ethylene production trend in the process of fruit shelf-life, the ethylene production in persimmon fruit was studied. For this goal, on-line sensitive gas monitors are needed. Traditional techniques like chromatographs are of limited use in air composition control measurements due to their restricted sensitivity. On other side, actually several laser-based methods have show to be much more sensitive, like photoacoustic. CO_2 laser photoacoustic spectroscopy is a very promising technique for the detection of ethylene with high sensitivity of parts-per-billion-volume (ppbv).

The experiments were performed over a period of 2 months, in a laboratory at a temperature of 25 °C and a relative humidity of about 62 %.

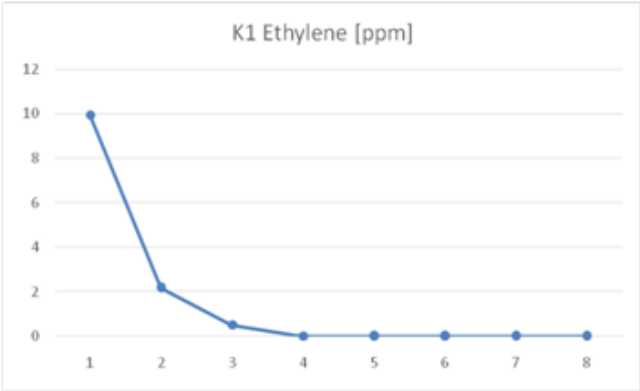

Fig. 1 The evolution of ethylene

CO_2 laser photoacoustic spectroscopy has been used as a non-invasive method to provide information on the evolution of internal ethylene produced in persimmons stored over 2 months. It was found that the high production of ethylene in the first days is significantly reduced after two weeks of storage.

Keywords: persimmon, ethylene, laser, photoacoustic.

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S2 P6

POLARIZING PHASE-SHIFTING INTERFEROMETRY FOR SURFACE PROFILE MEASUREMENT

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Phase-shifting interferometry [1] is commonly used in optical profilometry, where phase steps [2] are introduced by precisely translating one of the interferometer mirrors. In the present work, it is proposed that these phase steps be introduced through polarization control [3] within a common input/output polarizing interferometer [4]. The method involves rotating a half-wave plate in increments of 22.5°, while an equivalent optical path difference is defined to account for the measured profiles. This method also incorporates several broadband illumination sources (LEDs), the two-wavelength phase-shifting interferometry technique, and the use of achromatic waveplates and broadband optical components. The approach improves upon existing methods by offering more robust and precise phase shifts that are independent of wavelength. The procedure is described theoretically and validated by measuring the profile over a 2.38 mm × 1.78 mm area on a standard object with the nominal step-height of 1 μm. For comparison, Atomic Force Microscopy (AFM) profile of the sample is also presented.

Keywords: profilometry, phase-shifting interferometry, polarization.

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S2 P7

THE COLD ATMOSPHERIC PLASMA REACTOR WITH DIELECTRIC BARRIER DISCHARGE: FROM LABORATORY TO FARM

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Plasma, often referred to as the fourth state of matter, is a dynamic form distinguished by its unique properties. Unlike solids, liquids, and gases, plasma consists of ionized particles that conduct electricity and respond to magnetic fields. Found naturally in phenomena like lightning and auroras, plasma opened new possibilities across various fields, including medicine, energy, and now, agriculture. In a sustainable agriculture, cold atmospheric plasma reactors with dielectric barrier discharge represent a groundbreaking innovation in agriculture. These systems employ ionized gases such as nitrogen, air, or helium at atmospheric pressure to treat seeds and plants. The process enhances seed germination, strengthens plant resistance to diseases, and improves crop yields, all while minimizing the need for chemical fertilizers, pesticides, and herbicides. This directly addresses the growing demand for environmentally friendly agricultural practices that reduce pollution and soil degradation. Moreover, the implementation of cold atmospheric plasma technology aligns with the European Union's vision for a smart, sustainable, competitive, resilient, to ensure long-term food security. This vision emphasizes innovation, digitalization, and eco-friendly practices to ensure long-term food security and the well-being of rural communities. As global agriculture faces increasing challenges such as climate change, soil depletion, and the need to feed a growing population, sustainable solutions like cold atmospheric plasma technology have become bottom-line. It represents a shift towards a more responsible food production system, balancing agricultural efficiency with environmental care. Thus, the integration of cold atmospheric plasma technology in agriculture paves the way for global challenges while ensuring shaping the future of farming towards a greener system.

Keywords: cold atmospheric plasma, dielectric barrier discharge, sustenability, agricultural efficiency.

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S2 P8

CHARACTERISTICS OF THE PLASMA USED FOR THE SYNTHESIS OF NANOMETRIC W DUST IN AN H_2/N_2 MAGNETRON DISCHARGE

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This work presents the results of the plasma investigations used for the synthesis of W nanoparticles (dust) from the vapor phase in magnetron sputtering gas aggregation (MSGA) [1] cluster source operated in H_2/N_2 mixture. Usually, the MSGA cluster source is operated using Ar [1]. Surprisingly, W-based dust was obtained in H_2/N_2 mixture, starting with 25% N_2 content in discharge. The experiments were performed at two different pressures – 0.08 mbar and 0.8 mbar – for which the discharge was sustained in a gas mixture of H_2/N_2 at different concentrations.

The dust synthesis process was investigated by energy dispersive quadrupole Mass Spectrometry (MS) in PosIons mode and by Optical Emission Spectroscopy (OES) [2].

In the low m/z mass region of the mass spectra (0-50 amu), the peaks related to H-species (H_x^+, x=1-3) are present together with the peaks corresponding to N^+, NH^+, and N_2^+. The spectra also contain some well-separated peaks attributed to impurities (O^+, OH^+, H_2O^+). The presence of the high-mass species in the range of 190-280 amu [2], like WN_x^+, $WN_xH_y^+$ (x = 0-5; y = 0-5), at high pressure (0.8 mbar), where the dust formation is favored, suggests that these species may act as dust nucleation centers. OES spectra confirm the presence in the discharge of the W, H_2, N_2, and impurities species (WI and H_a emission lines, N_2, H_2, and OH optical emission molecular bands).

The identification of W (OES), and W^+, WN^+ (MS) confirms the presence of species for W-based dust synthesis in the MSGA chamber, obtained through target sputtering in an H_2/N_2 atmosphere. Further research will focus on the nucleation mechanism of the dust.

These results are relevant for nanotechnology and various processes that involve tungsten components in contact with plasmas. Especially in fusion applications, small amounts of N_2 are injected into the fusion plasma to facilitate divertor radiative cooling [3]. In addition, the question arises whether this process causes the generation of tungsten dust [4].

Keywords: magnetron sputtering, plasma diagnostics, tungsten isotopes.

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S2 P9

SINTHESYS AND CORROSION RESISTANCE EVALUATION OF THERMIONIC VACUUM ARC CHROMIUM NITRIDES COATINGS

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An experimental set-up that allows N_2 gas precursor seeding of a classical Thermionic Vacuum Arc (TVA) chromium plasma source was developed and employed as a new hybrid route for obtaining CrN_x protective coatings. More details on the principle of TVA deposition technique are described elsewhere [1]. Here, we present the influence of the seeded N_2 gas precursor flow on the morphology, composition and structure of the coatings investigated by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS) and Grazing Incidence X-ray Diffraction (GIXRD). The EDS measurements showed an increase of N/Cr ratio with increasing N_2 flow while the XRD analysis revealed the crystalline structure of the coatings. Moreover, as presented in figure 1, a phase transformation from Cr_2N to CrN occurs increasing the seeded N_2 flow. Moreover, the influnce of nitride phases presence in the coating on their corrosion resistance by means of polarization curves measurements are presented. An increase of coatings corrosion resistance with increasing the nitrogen content was observed.

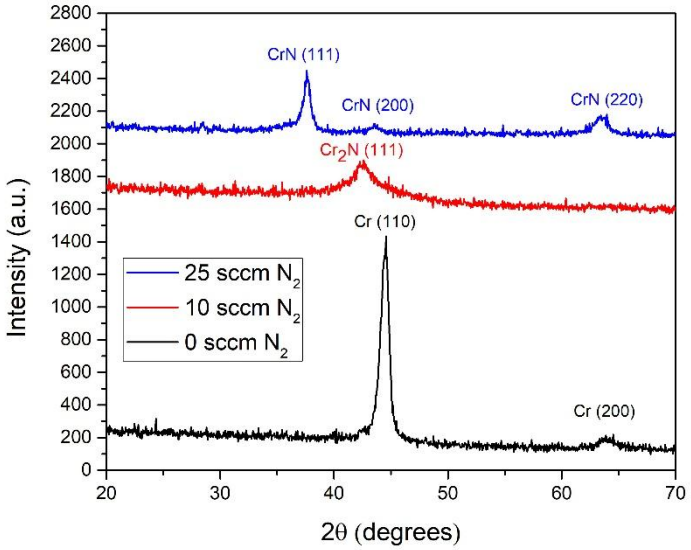

Fig. 1 GIXRD patterns of the films deposited at three different N_2 flow rates highlighting the phase changes induced by increasing the N_2 flow.

Keywords: Thermionic Vacuum Arc, coatings, chromium nitrides

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S2 P10

ENHANCING H. PYLORI DETECTION: A PHOTOACOUSTIC SPECTROSCOPY APPROACH FOR MULTI-GAS BREATH ANALYSIS

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Helicobacter pylori (H. pylori) is a pathogenic bacterium that plays a significant role in the development of various gastrointestinal disorders, including peptic ulcers, chronic gastritis, and stomach cancer [1]. One of its key characteristics is the enzyme urease, which facilitates the breakdown of urea into ammonium carbonate, making it a critical biomarker for detecting H. pylori infections. Although current diagnostic methods, such as the Ammonia Breath Test, focus on measuring ammonia levels, there is a growing interest in exploring more comprehensive approaches to improve diagnostic accuracy.

In this study, we present a novel diagnostic technique using photoacoustic spectroscopy to simultaneously measure ethylene, carbon dioxide, and ammonia concentrations in the breath of individuals infected with H. Pylori[2-4].

Our findings show significant differences in the breath composition of infected individuals compared to healthy controls, with elevated levels of ethylene, carbon dioxide, and ammonia.

These results suggest that a combined analysis of these gases could offer a more precise and reliable method for detecting H. pylori, potentially overcoming the limitations of existing breath-based diagnostics and providing a more holistic approach to identifying infection.

Keywords: laser photoacoustic spectroscopy; Helicobacter pylori; IR spectroscopy; biomarkers

Acknowledgments: This work was supported by the Romanian Ministry of Research, Innovation and Digitalization under the Romanian National project number PN-III-P1-1.1-TE-2021-0717.

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S2 P11

INVESTIGATING POST-HARVEST RESPIRATION OF CONFERENCE PEARS FROM DIFFERENT SOURCES USING CO_2LPAS

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Maintaining the quality and extending the shelf life of harvested fruits are critical challenges within the agri-food sector, directly impacting consumer satisfaction and reducing post-harvest losses [1]. Fruit respiration, a fundamental physiological process, plays a pivotal role in these aspects, influencing the rate of metabolic changes and the production of volatile organic compounds (VOCs) [1, 2]. Traditional methods for analyzing these gaseous emissions often suffer from limitations in sensitivity and the ability to perform real-time, non-invasive monitoring, hindering a comprehensive understanding of the dynamic physiological changes occurring during storage. To address these limitations, laser-based techniques, particularly photoacoustic spectroscopy (PAS), have emerged as highly valuable tools for trace gas detection [3]. Among PAS techniques, CO_2 laser photoacoustic spectroscopy (CO_2LPAS) stands out for its high sensitivity and specificity in detecting a range of relevant respiration gases. In this study, CO_2LPAS was employed as a highly sensitive detector to investigate the respiration patterns of Conference pears sourced from two distinct origins: untreated pears from a local source and commercially stored pears obtained from a supermarket. The concentrations of key volatile compounds – ethylene (C_2H_4), ethanol (C_2H_6O), and ammonia (NH_3) – were continuously monitored under simulated shelf-life conditions. Our results revealed significant differences in the VOC emission profiles between the two groups of pears. Notably, ethylene emission peaked earlier in the supermarket pears compared to the locally sourced pears. This observation likely reflects the impact of post-harvest treatments applied during commercial storage to control ripening. Furthermore, ethanol concentrations gradually accumulated over time in both groups, indicating the progression of fermentation-related deterioration as the fruit senesced. A particularly interesting finding was the significant increase in ammonia (NH_3) levels during the late stages of senescence in both types of pears. This observation suggests a potential role for ammonia as a novel biomarker for advanced fruit degradation, warranting further investigation. Furthermore, the identification of ammonia as a potential novel biomarker for late-stage senescence opens new avenues for developing more accurate indicators of fruit quality and shelf life. The insights gained from this research can contribute to the development of improved storage and distribution strategies aimed at minimizing post-harvest losses and ensuring the delivery of high-quality fruit to consumers.

Keywords: Pear respiration, volatile organic compounds, CO_2 laser photoacoustic spectroscopy, post-harvest quality.

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ABSTRACTS

S3 – Nuclear and sub-Nuclear Physics and Applications

- *Nuclear and subnuclear sciences and Engineering*
- *Advanced detection systems*
- *Accelerated particle beams*
- *Nuclear Techniques and applications*
- *Nuclear Safety an Radiation Protecțiuni*

S3 L1

ASSESSMENT OF THE POTENTIAL CONSEQUENCES OF A NUCLEAR DEVICE DETONATION EVENT

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The paper analyses the potential consequences on the Romanian territory following a hypothetical case scenario involving a nuclear device detonation (NDD) on the Snake Island and also others areas, in the context of military conflict in Ukraine. The assessments have been performed by researchers from National Institute of Physics and Nuclear Engineering (IFIN-HH) and National Commission for Nuclear Activities Control (CNCAN) which are constantly involved in emergency preparedness and response management activities using decision support systems in conjunction with the domestic radiological assessment tool CBRNE Software. The paper is focusing on immediate and longer-term impacts across environmental, societal, and infrastructural domains. Through quantitative modeling and qualitative analysis, we assess blast pressure effects, radiation exposure, and thermal burn effects, alongside secondary effects such population displacement. The study integrates historical data, modern simulation techniques, and scenario-based projections to estimate casualty rates, infrastructure damage, and recovery timelines under varying detonation scales and locations. Societal responses, including governance challenges and public health crises, are examined to highlight resilience gaps. Our findings underscore the catastrophic potential of such an improbable but still possible event, emphasizing the need for robust preparedness, international cooperation, and mitigation strategies to minimize risks and enhance recovery capacity.

Keywords: nuclear device detonation, atmospheric dispersion, impact assessment

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S3 L2

MEASUREMENT OF EFFECTIVE CROSS-SECTION OF THE ^{176}Yb (n, γ)^{177}Yb REACTION FOR NUCLEAR MEDICAL PURPOSES

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Due to its physical and chemical characteristics, ^{177}Lu is a very attractive radionuclide for use in nuclear medicine. Both the "direct" and "indirect" reactor production methods have been used to obtain ^{177}Lu for nuclear medicine purposes. The direct production method of ^{177}Lu is done through ^{176}Lu(n,γ)^{177}Lu reaction, whereas the indirect production method is carried out via ^{176}Yb(n, γ)^{177}Yb →177Lu reaction [1].

The aim of the present work was experimental measurement of effective cross section of ^{176}Yb (n, γ)^{177}Yb reaction, as part of the indirect production method of ^{177}Lu, which depends on the fraction of epithermal neutrons in the neutrons spectrum.

The effective cross-section of the ^{176}Yb (n, γ)^{177}Yb reaction in the thermal and 1/E regions neutron spectrum of the Tehran Research Reactor were measured by the activation method with the cadmium ratio method. The ^{176}Yb (n, γ)^{177}Yb reaction was studied by irradiating pure Yb_2O_3 sample enriched by ^{176}Yb to 98.5%. The flux parameters of the irradiation position include the thermal and epithermal neutron fluxes and deviation parameter (α) of the neutron distribution from the 1/E law were measured using ^{197}Au(n,γ)^{198}Au and ^{59}Co(n,γ)^{60}Co monitor reactions. In order to improve the uncertainties results, the samples and monitors were mixed and irradiated in the same position. The measurements were based on the Cd-covered and without Cd covered irradiations of both the samples and monitors. The induced activities in the samples were measured by an HPGe detector calibrated in efficiency using gamma-lines of ^{133}Ba, ^{152}Eu, ^{137}Cs, ^{60}Co and ^{241}Am calibration sources at the same geometry used for the cross-section measurements. The obtained results were compared with the existing experimental and evaluated data and discussed [2,3].

Keywords: effective cross-section, ^{176}Yb (n, γ)^{177}Yb reaction, nuclear medical applications, Tehran Research Reactor (TRR)

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S3 O1

ANALYSIS OF COLLECTIVE FLOW OF HADRONS PRODUCED IN RELATIVISTIC HEAVY-ION COLLISIONS

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Relativistic heavy-ion collisions offer the possibility of investigating the nuclear matter under extreme conditions of density and temperature. They push the nuclear matter to its limits, being a unique tool for recreating the state of matter that existed in the early Universe or the matter that is found in the core of neutron stars. Various experimental programmes, such as RHIC Beam Energy Scan (BES), Facility for Antiproton and Ion Research (FAIR), Nuclotron-based Ion Collider Facility (NICA) are focused on exploring different regions of the QCD phase diagram using heavy-ion collisions at high energies as an experimental method. The matter produced in these collisions undergoes complex dynamics and can be studied in greater detail through the collective characteristics highlighted by the obtained data. This study makes use of the experimental measurements of transverse momentum distributions collected from the STAR experiment in Au-Au collisions at RHIC-BES energies ($\sqrt{s_{NN}}$ = 7.7 GeV, 11.5 GeV, 19.6 GeV, 27 GeV and 39 GeV). We will present a study of the average transverse momentum of identified hadrons as it provides valuable insights into the collective expansion of nuclear matter generated during these collisions. The focus will be on the mean transverse momentum $\langle p_T \rangle$, and its dependence on particle species and event centrality at various incident energies will be presented and discussed. Different behaviors of strange hadrons compared to non-strange hadrons were observed. Furthermore, two distinct linear behaviors have been identified for mesons and baryons by plotting the dependence of the mean transverse momentum on the reduced hadron mass. In order to deepen our interpretation of the data, the results were compared to model calculations, obtained by AMPT simulations. By using AMPT simulations, we were able to consider two different scenarios of the evolution of the system: the string melting version and the default version, which does not include the string melting phase. It was observed that the default version provides a more accurate representation of the $\langle p_T \rangle$ behavior for (anti)baryons, while it overpredicts the $\langle p_T \rangle$ of ϕ and K^{*0} mesons. Whereas the string melting version of AMPT better describes the $\langle p_T \rangle$ of mesons, it underpredicts the values corresponding to (anti)baryons. By combining these approaches, the aim is to improve our understanding of the system generated in relativistic heavy-ion collisions offering a more precise view of the nuclear matter behavior under extreme conditions.

Keywords: relativistic heavy-ion collisions, quark-gluon plasma, collective flow, AMPT model

S3 O2

TRITIUM EXTRACTION FROM HELIUM PURGE GAS IN FUSION REACTORS

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A commercially viable fusion power plant must fulfill two essential and interdependent functions: (1) breeding tritium to ensure fuel self-sufficiency and (2) extracting high-grade thermal energy to enable efficient electricity generation. These requirements are fundamental to the sustainability and economic viability of a fusion reactor. The breeding blanket—a complex, multifunctional component that surrounds the plasma—is the critical system responsible for enabling both processes. It must convert the high-energy neutrons released during fusion reactions into usable thermal energy and simultaneously facilitate the generation and recovery of tritium, the primary fuel component in deuterium-tritium (D-T) fusion.

Given the short half-life and scarcity of tritium in nature, a fusion power plant must achieve tritium self-sufficiency, meaning it must breed at least as much tritium as it consumes. To accomplish this, lithium-containing materials—either in solid ceramic form or as part of a liquid metal alloy—are incorporated into the breeding blanket to react with fusion neutrons and produce tritium. The extraction of bred tritium from these materials in a timely and efficient manner is vital to maintain a closed fuel cycle and minimize radioactive inventory.

The DEMO (Demonstration Power Plant), which will succeed ITER, represents the first experimental fusion facility designed not only to demonstrate scientific feasibility, but also to deliver electricity to the grid on a continuous basis. DEMO is therefore a pivotal step toward commercial fusion power and will bridge the gap between large-scale research reactors and full-scale industrial fusion plants.

Under the EUROfusion programme, four breeding blanket (BB) concepts are being developed for evaluation and potential deployment in DEMO. Among these, two concepts use helium purge gas specifically for tritium extraction. In these systems, helium serves not only as a coolant (in some designs), but more importantly as a non-reactive carrier gas that sweeps through the breeder zone and removes the bred tritium in gaseous form. The helium purge gas containing tritium is subsequently directed to a tritium extraction system (TES), where tritium is isolated, purified, and transferred back to the fuel cycle.

This paper focuses on the development, optimization, and proposed implementation of the tritium extraction system from helium purge gas for application in the DEMO plant. The design must meet stringent criteria regarding extraction efficiency, system integration, tritium inventory control, radiation resistance, and compatibility with blanket materials.

Keywords: DEMO, TER, tritium, self-sufficiency

S3 O3

DSTAU EXPERIMENT: STUDY OF TAU NEUTRINO PRODUCTION

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on behalf of the DsTau (NA65) collaboration

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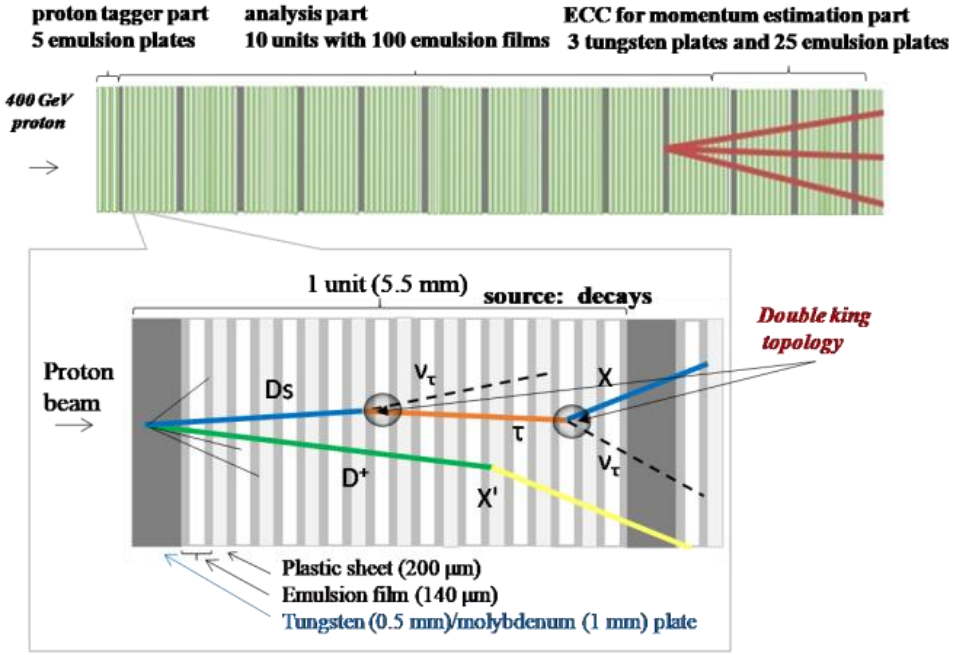
NA65(DsTau) is an experiment at CERN. The project aims is to study tau-neutrino production in high energy proton-nuclei interactions (400 GeV at SPS) and to provide important information for future ντ measurements from a highest ντ statistics expected [1].

First direct evidence of tau-neutrino interaction was reported by the DONUT experiment, they measured the ντ charged-current cross section, but this was done with a systematic uncertainty larger than 50% [2]. Therefore, one of project goals is to improve the ντ CC cross-section accuracy by reducing the systematic uncertainty in the cross section evaluation to the 10% level. This can be done by detecting decays of Ds mesons ($D_s^+ \rightarrow \tau^+ \nu_\tau \rightarrow X \upsilon_\tau \overline{\upsilon_\tau}$ and $D_s^- \rightarrow \tau^- \upsilon_\tau \rightarrow X \overline{\upsilon_\tau} \upsilon_\tau$) for this, nuclear emulsions are the most suitable devices because their high spatial and angular resolution. DsTau collaboration used an experimental set-up which includes emulsion plates interlead with plastic and tungsten/molibden, presented in next figure.



DsTau experimental set-up

The first result of the data analysis for the pilot run was just published. The result shows a good precision in vertex reconstruction, proton interaction length, proton charge, particle multiplicities in a condition of high-track density environment. The real data were comparing with MC (Geant4) simulation data [3].

Keywords: DsTau experiment, nuclear emulsion, tau neutrino,

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S3 O4

MONTE CARLO SIMULATION FOR LASER DRIVEN MUON PRODUCTION AT ELI-NP

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The sea-level flux of muons naturally produced through the decay of pions and kaons in extensive air showers is relatively low (approximately 1 particle/cm²/s), and is characterized by variability in both energy and direction.

The ability to determine and control the energy and propagation direction of muons offers significant advantages for various applications, including muography, nuclear security diagnostics, muon-catalyzed fusion etc. Therefore, we investigated the possibility to generate a stable and tunable muon source using ultra-short, ultra-intense laser pulses at the Extreme Light Infrastructure – Nuclear Physics (ELI-NP) facility.

This study and the presented results are based on a series of simulations using Monte Carlo methods implemented in the GEANT4 framework. In these simulations a general experimental setup representative of the facility's experimental chambers was considered. Key experimental components were varied in the simulation to determine the optimal conditions for muon production. Different energy spectra for electron beams generated through the interaction of the laser pulse with gas in the interaction chamber were investigated, as well as the properties of the target with which these electrons subsequently interact.

The resulting muon beam was analyzed and characterized for three distinct electron energy spectra. For one of these spectra, two different target materials and two target thicknesses were evaluated.

Muons originating from pion decay and those produced via gamma pair-production were both analyzed, revealing a clear distinction between the two production channels. In addition to muons, a significant background of secondary particles - primarily neutrons and photons - was also observed.

Keywords: muography, laser driven muon beams, GEANT4 simulations, ELI-NP

S3 O5

SEARCH OF MULTI-NEUTRON SYSTEMS USING CLASSICAL AND MACHINE LEARNING METHODS

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Over the years, a significant challenge in nuclear physics has been the exploration of multi-neutron systems due to their inherent instability. Although multi-neutron bound systems have been studied for decades, definitive evidence for stable states involving the dineutron and trineutron remains elusive. The existence of the tetraneutron has been the subject of intense scrutiny, with various experimental methods employed to detect it. Remarkably, in 2022, an international team, including our group, reported the observation of a tetraneutron state - a breakthrough achieved through the knockout of an α particle from a high-energy ^{8}He projectile induced by a proton target. Experimental searches for the pentaneutron have yielded inconclusive results, aligning with theoretical predictions suggesting its high instability. Recent efforts have also addressed the hexaneutron system, with preparations for further exploration using reactions such as (p,2p) and (p,pα).

In the last 12 years, at GSI-Darmstadt (Germany) were conducted an extensive series of experiments, employing various setups and techniques, which had among their goals to explore the existence and properties of multi-neutron systems. The complex experimental data extracted from this experiments were analysed employing classical data analysis techniques which required a specific analysis chain to be respected: firstly, preprocessing of experimental data is crucial, involving event reconstruction, calibration, and background subtraction to prepare it for further analysis. Next task is the development of analysis algorithms to identify characteristic signatures of multi-neutron systems in the experimental data, guided by domain knowledge and theoretical models. The machine learning (ML) algorithms is a new approach which can significantly improve the efficiency in reconstruction of uncharged particles events by learning the most probable events without an explicit implementation of the physics laws. This involves training machine learning models to recognize and classify multi-neutron events based on their distinct features.

Both classical and ML methods require well-preprocessed data as input, which include data cleaning, normalization, calibration; also, both methods need a selection of appropriate features from experimental data that are indicative of the presence or characteristics of multineutron systems, such as energy deposition patterns, particle trajectories, and angular correlations. Further steps in our analysis diverge: while the classical methods use various well-established algorithms to analyse data, ML methods require a series of steps such as training data preparation, model training, evaluation and deployment or iterative refinement. Using ML methods for the search of multineutron systems, offers several advantages, including the ability to automatically analyze large volumes of experimental data, identify subtle patterns and correlations that may be challenging for manual analysis, and potentially discover new insights into the properties and behavior of these exotic nuclear configurations.

Keywords: high energy physics, multi-neutron systems, analysis techniques, ML algorithms.

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S3 O6

ESTIMATING THE MOMENTUM OF PARTICLES RECORDED IN THE DsTau(NA65) NUCLEAR EMULSION DETECTOR

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The DsTau (NA65) experiment, approved by CERN in 2019, aims to improve our understanding of tau neutrino production, a crucial step in exploring the properties of this relatively new particle. By precisely measuring the differential production cross-section of the charmed Ds meson, using the sequential decay $Ds \rightarrow \tau + \nu\tau$, followed by $\tau \rightarrow X + \nu\tau$, the experiment seeks to reduce the systematic uncertainty on the tau neutrino flux to below 10%. This is particularly important for future neutrino oscillation studies and for improving the precision of next-generation neutrino experiments. High-energy (400 GeV) protons interactions with tungsten and molybdenum targets are expected to yield approximately 1000 $Ds \rightarrow \tau + \nu\tau$ decays and around 10^5 charm pairs.

Given the very short decay lengths and small decay angles associated with these events, nuclear emulsion films were chosen for their exceptional spatial resolution, which can reach 50 nm. This property is essential for tracking the almost invisible decay signatures and enables full event reconstruction at the microscopic level.

A key aspect of the analysis involves the momentum estimation of charged particles using the Multiple Coulomb Scattering (MCS) method. This technique allows for indirect momentum measurement by analyzing angular deviations as particles passes through dense materials, like tungsten and molybdenum. During the 2023 DsTau physics run, two dedicated emulsion modules were built specifically to validate this approach by using muon and hadron beams of already known energies.

Since then, the emulsion films have been successfully scanned using the Hyper Track Selector (HTS) system in Nagoya, Japan, and an initial reconstruction of the data has been completed. The current phase focuses on testing and refining the alignment of the emulsion layers—an essential step to ensure the accuracy of momentum estimation done by the MCS method. This analysis is also identifying and addressing challenges encountered during alignment process of nuclear emulsion detectors exposed to multiple particle beams, as opposed to a single beam exposed uniformly across the detector's surface.

Keywords: DsTau(NA65) Experiment, nuclear emulsion, momentum

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S3 O7

DESIGN AND PERFORMANCE STUDY OF A VERY COMPACT AND GRANULAR ELECTROMAGNETIC CALORIMETER

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In current and future particle physics experiments, large calorimeters play a crucial role due to their ability to provide essential information about particle collisions. Calorimeters offer detailed insights into the particle flow in events, such as transverse energy, missing energy, energy of single jets, and can significantly aid in particle identification. The need for highly compact [1], high-resolution, and radiation-tolerant calorimeters has become central to both current and future experiments.

Extreme technological challenges on compactness and granularity hold for special electromagnetic calorimeters used to measure e.g. the luminosity, or the number and energy of electrons and positrons in laser photon – electron scattering with strongly varying multiplicity. For the precise definition of the fiducial volume, or the ability to resolve overlapping showers, a small Molière Radius is essential.

This work presents the design and performance studies of a compact and highly granular electromagnetic calorimeter (ECAL-P), developed in the context of two major collaborations: LUXE (Laser Und XFEL Experiment) at DESY, and DRD on Calorimetry (DRD6) at CERN. The calorimeter design, known as ECAL-P, has been developed to meet the stringent spatial and performance constraints of the LUXE experiment [2]. Within the DRD-on-Calorimetry collaboration, this development is part of a broader coordinated effort to standardize calorimeter R&D across the community.

ECAL-P is in the construction phase. An overview of the used technologies will be given and results from measurements of instrumented ultra-thin sensor planes, read out with a dedicated front-end electronics, will be reported.

Keywords: Electromagnetic cascades; Sampling calorimetry; MC simulations; LUXE, DRD6

Acknowledgements: This study was partly supported by the the Romanian Ministry of Research, Innovation, and Digitalization under Romanian National Core Program LAPLAS VII – contract no. 30N/2023 and under Romanian National Program CERN-RO - contract no. CERN-RO/CDI/2024-005.

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S3 P1

NON-EVAPORABLE GETTER MATERIALS FOR TRITIUM CAPTURE IN FUSION REACTOR PURGE SYSTEMS: A PRELIMINARY STUDY

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Non-evaporable getter (NEG) materials are promising candidates for tritium capture from helium purge gas streams in solid breeder blankets of fusion reactors. This preliminary study evaluates several getter materials for application in tritium extraction systems. The materials investigated include depleted uranium, ZrCo alloy, and three commercial NEG alloys developed by SAES Getters: ST101 (Zr-Al), ST707 (Zr-V-Fe), and ZAO (Zr-V-Ti-Al).

The selection of suitable getter materials is guided by critical performance criteria: low equilibrium hydrogen pressure at adsorption temperatures (~30 °C), low desorption temperature (<500 °C), high hydrogen storage capacity, resistance to embrittlement, and stable performance over repeated adsorption/desorption cycles. NEG alloys, especially Zr-based systems, are attractive due to their high specific pumping speed, robust cycling behavior, and inherent safety—they retain hydrogen without release unless externally heated, minimizing risks during power failures or system malfunctions.

Recent advancements in ZAO alloy sintered elements demonstrate effective operation at moderate temperatures (150–200 °C) with low power demand, making them strong candidates for integration into fusion systems. ZrCo, while less efficient kinetically than uranium, is a safer and more manageable alternative for reversible tritium storage and capture from inert gas streams, though it may be susceptible to disproportionation at high temperatures. Compared to depleted uranium, ZrCo features lower pyrophoricity and reduced volumetric expansion during hydrogen absorption.

These preliminary results provide a comparative assessment of getter materials for tritiated hydrogen (Q_2 = HT, T_2) removal from fusion reactor purge systems, supporting the design of safe and efficient tritium extraction technologies for next-generation fusion power plants.

Keywords: NEG, DEMO, TER, tritium, extraction

S3 P2

CHARACTERIZATION OF REACTIVE ZEOLITES FOR TRITIUM EXTRACTION FROM FUSION REACTOR PURGE GAS

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In helium-purged fusion reactors breeding blankets, such as those employing solid breeder blankets, tritium is extracted from the breeding zone primarily in the form of elemental tritium (T_2, HT) and tritiated water vapor (HTO). Efficient removal of these species from the helium purge gas stream is essential for maintaining fuel self-sufficiency, minimizing tritium inventory, and enabling safe and effective recycling within the fuel cycle.

To support the development of scalable solutions for helium purge gas treatment by recovering the tritiated water vapors, a 1:10 scale experimental mock-up of a sorbent bed system has been

designed, constructed, and fully commissioned. The test rig simulates key functional aspects of purge gas handling systems, with emphasis on water trapping and hydrogen isotope exchange dynamics.

Initial experiments focused on evaluating a Na-Y type zeolite molecular sieve doped with 0.3 wt% platinum (Pt) and characterized by a 5:1 SiO_2/Al_2O_3 mole ratio. Three tests were conducted at temperatures of 25 °C, 65 °C, and 80 °C, using deuterium as a non-radioactive tracer to study the isotopic exchange process. Real-time monitoring of the deuterium concentration in the exit helium stream was performed via mass spectrometry, and internal temperatures were tracked at multiple points along the sorbent bed to assess thermal uniformity.

The results demonstrated high deuterium removal efficiencies, reaching 97.92% at 65 °C and 98.52% at 80 °C after a 10-hour operation period. These values establish a reliable performance reference for sorbent-based isotope exchange systems in fusion applications. The findings confirm the potential of platinized zeolite materials to simultaneously manage tritiated moisture and elemental tritium species in purge gas streams. Future testing will explore the performance of sieves with increased platinum content (0.5 and 0.7 wt%) under varied operating conditions to further optimize tritium extraction efficiency.

Keywords: RMSB, DEMO, TER, tritium, extraction

S3 P3

OPTIMISATION OF CT SIMULATION SCANNING PROTOCOLS – ADVANTAGES IN SRS AND SBRT TREATMENTS

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Given the continuing desire to increase accuracy and precision in the delivery of radiotherapeutic treatments, methods are needed to minimize the uncertainties that can arise throughout the treatment chain. One of the key elements in the accuracy of treatment delivery is the images acquired with the CT scanner. Based on this information, the geometric localization of the volume to be irradiated, generically referred to as the target volume, as well as the virtual calculation of dose propagation inside the patient are performed.

With the technological evolution, it is necessary to update the procedures used for patient scanning, given the increased detection and processing capabilities, in order to obtain more qualitative and ultimately more clinically conclusive data.

This issue becomes increasingly significant in short session treatments (1–5 fractions) where high doses per fraction (5Gy–20Gy) are delivered. Given the low number of fractions, relative to conventional treatments with around 20–25 fractions, the random element of error starts to become non-mediating [1] and can produce significant deviations in treatment delivery if this aspect is not adequately compensated for. Also, treatments with high dose per fraction (>5Gy) require specific dose constraints [2] for healthy tissues, because of different radiobiological phenomena compared to those applied for conventional fractionation (1.8Gy-2Gy), which may induce significant side effects.

The aim of this work is to test and optimize the CT scanner acquisition and processing parameters so that the data or data series used to perform the entire chain of processes will ultimately produce a decrease in the uncertainty of treatment delivery. Specifically, the available reconstruction algorithms [3] will be tested, as well as the modification of slice thickness, slice-to-slice thickness and scan diameter.

Keywords: Radiotherapy, Radiosurgery, CT Simulation, Scanning Protocols

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S3 P4

ENHANCING THE TECHNICAL SOLUTIONS FOR CLOSURE OF BAITA BIHOR REPOSITORY USING MINERAL INDIGENOUS AGGREGATES (ORE) IN DEVELOPING CONCRETE ENGINEERING BARRIERS

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The Baita Bihor repository is located in the north-western part of the Carpathian Mountains in an old uranium mine. It has been receiving institutional radioactive waste since 1985 and is intended for the final disposal of low and intermediate radioactive waste (including DSRS's) resulting from industrial, medical and research activities, as well as waste resulting from decommissioning activities. The repository is operated by the Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH) and it is estimated that the repository will be closed after 2040. The concrete matrix for the closure of a radioactive waste repository plays a vital role in long-term containment and isolation of conditioned radioactive materials. It is designed not just for structural support, but also as a barrier to prevent the human intrusion and the migration of radionuclides from the repository. Designing a concrete matrix is a highly specialized task and it must maintain structural integrity for hundreds of years. Creating a concrete matrix for closure barriers using indigenous (locally available) materials is both practical and cost-effective but the goal is to adapt local resources to international standards while maintaining safety and long-term performance. Using uranium ore as mineral aggregate requires careful consideration of both the chemical and radiological properties of the waste. Durability and stability of the concrete over long periods takes into consideration criteria as: low permeability to water and gases, long-term durability, 300+ years design life, chemical stability in contact with waste and groundwater, resistance to radiation-induced degradation, resistance to cracking and swelling.

Keywords: (repository, ore, concrete, waste)

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S3 P5

INVESTIGATION OF MECHANICAL BEHAVIOUR OF DIFFERENT CEMENT MATRICES WITH SORBENTS USED IN RADIOCESIUM ADSORBTION PROCESS

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A major concern in radioactive waste management is the treatment of liquid radioactive effluents. During the treatment of aqueous radioactive waste by adsorption process results secondary radioactive waste which must be conditioned in a long-term stable matrix.

Adsorption of radioactive cesium can be achieved using a synthetic inorganic sorbent that selectively extracts cesium isotopes. The sorbent used in the cesium adsorption process, once exhausted, will become secondary radioactive waste that must be conditioned for final disposal. The immobilization of radioactive waste in Portland cement matrix is the most used method, applied in the world by the countries developing nuclear energy programs. The knowledge about the mixing effect of cement with certain radioactive wastes is limited, which leads to the different experimental tests to optimize the cement-waste matrix. The conditioning matrix must be a monolith with acceptable mechanical, chemical and physical properties that are maintained over a long period of time.

This paper gives information about the influence of different sorbents that can be used for the liquid radioactive waste treatment for removal of cesium on the cement matrix. Once of the most relevant properties applicable to cement-based material is compressive strength. A high compressive strength corresponds to a long-term stability structural of the cement waste form.

In this study was used commercially available composite cement CEM II B/M(S-LL) 42,4 R as the binder material and as sorbents were used dacit, riolit and bazalt. These materials have the following advantages: high mechanical and thermal stability, chemical inertness, ion exchange properties, good adsorption properties and selectivity towards different chemical species, low cost and high availability.

Samples based on Portland cement with different concentrations of dacit, riolit and bazalt (30%, 50% and 100% by weight) were prepared and compared with the reference cement samples. On these samples was necessary to make tests of compressive strength in order to obtain optimal value of these sorbents concentration that does not influence negatively mechanical properties of the cement matrix. To investigate the mechanical behavior of these matrices, the samples kept in laboratory conditions were tested at the 7, 28 and 60 days for compression.

Keywords: Radioactive waste, Sorbents, Cement matrix, Mechanical tests.

S3 P6

GEOSPATIAL MODELING OF INDOOR RADON CONCENTRATION IN İZMİR PROVINCE (WESTERN TURKEY): A GEOSTATISTICAL AND GEOLOGICAL PERSPECTIVE

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Radon is an odorless, colorless, and carcinogenic gas that cannot be perceived by human senses and poses a significant health risk, particularly as a leading cause of lung cancer in individuals residing in enclosed spaces worldwide. This study aims to (1) assess Indoor Radon Concentrations (IRCs) in 117 residential buildings across İzmir, Turkey, (2) analyze the correlation between IRCs, Geological Units (GUs), and Active Faults (AFs), and (3) compare the obtained IRC values with the European Indoor Radon Reference Level (EIRRL) of 200 Bq/m³ to determine potential high-risk areas for lung cancer. IRC measurements were conducted using Solid State Nuclear Track Detectors (SSNTDs) within the selected buildings from February 2013 to March 2013. The collected data were mapped to visualize IRC distribution concerning GUs and AFs, and a geological cross-section was derived based on this mapping. Geostatistical modeling of IRCs in relation to AFs revealed that higher IRCs were generally detected in buildings situated near fault lines, with a pattern of increasing IRCs aligned with the directional trend of AFs. The highest measured IRC (487 Bq/m³) was recorded in a structure located on alluvium mainly derived from volcanic formations, whereas the lowest concentration (28 Bq/m³) was observed in a building situated on alluvial deposits predominantly originating from sedimentary formations. The statistical analysis yielded a minimum IRC of 28 Bq/m³, a maximum of 487 Bq/m³, and an arithmetic mean of 210 Bq/m³. The findings indicate that in İzmir, approximately 50% (59 out of 117) of the surveyed buildings exhibited IRCs surpassing the recommended EIRRL threshold of 200 Bq/m³. These results highlight the necessity for routine monitoring of indoor radon levels by relevant authorities and the implementation of mitigation strategies in buildings where IRCs exceed the safety threshold.

Keywords: Indoor radon concentration, geospatial modeling, active faults, solid state nuclear track detectors (SSNTDs)

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S3 P7

SRS PLAN QUALITY METRICS AND CLINICAL EXPERIENCE- A DATA REVIEW

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Brain tumor control plays an important role in the patient's neurological integrity and quality of life. The principle underlying radiosurgery treatments is the delivery of large doses, up to 24 Gy/fraction [1], to the tumor, sparing the healthy normal tissues. In order to obtain the best results a very precise delivery is necessary, which depends on several factors, such as immobilization devices, daily imaging, surface guidance, and a rigorous quality assurance program to maintain a sub-millimeter accuracy. The closer the prescription dose is matched to the treated target and the steeper the dose gradient around the target, the less normal tissue is irradiated.

This work aims to elaborate a compendium of our clinical data where we analyze industry standard and specific plan quality metrics according to target size and target proximity to various organs at risk in an effort to standardize our planning process and compare it with other peer reviewed data.

In this analysis, we look at individual "targets" defined as the planning target volumes (PTV) within the patient's brain. As one treatment plan can contain multiple lesions/PTV's and one treatment session can contain multiple plans, we have decided to analyze individual targets on the summation of all irradiated plans in order to take into account the dose contribution plans have on each other and the influence on the plan quality metrics we asses.

The plan quality metrics we asses are as follows: Conformity Index (CI), Homogeneity Index (HI), Quality of coverage, Gradient Index Paddick, Conformity Index Paddick [2], Conformity Index Lomax [3], Gradient Measure, etc.

We also briefly discuss on the effectiveness of the various plan quality indexes as worthwhile evaluation tools for choosing the right approach when elaborating the treatment plans.

Keywords: radiotherapy, stereotactic treatments, quality, indexes

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ABSTRACTS

S4 – Cross-disciplinary Applications of Physics

- *Nonlinear dynamics, complex systems and applications*
- *Biological complexity and genetics, Biophysics and bioengineering*
- *Econophysics*
- *Physics of Social Systems*

S4 L1

FROM DISTRIBUTIONS OF WAITING TIMES IN TIMESERIES TO ZIPF'S LAW. THE UBIQUITY OF SCALE-FREE DISTRIBUTIONS

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We present a series of detailed numerical results concerning the qualitative and quantitative properties of the distributions of waiting times observed in a broad set of timeseries pertaining to fiduciary and crypto-currency exchange rates, weather at large, automotive data, etc., with emphasis on the robustness of the scale-free distributions observed for small values of the threshold and the consistency of the results with respect to the length of the timeseries. We show how the aforementioned distribution can be used in privacy-preserving application through encrypted computations and then extend the definition of the waiting times to cover the statistics of large texts, with direct applicability on stylometric studies.

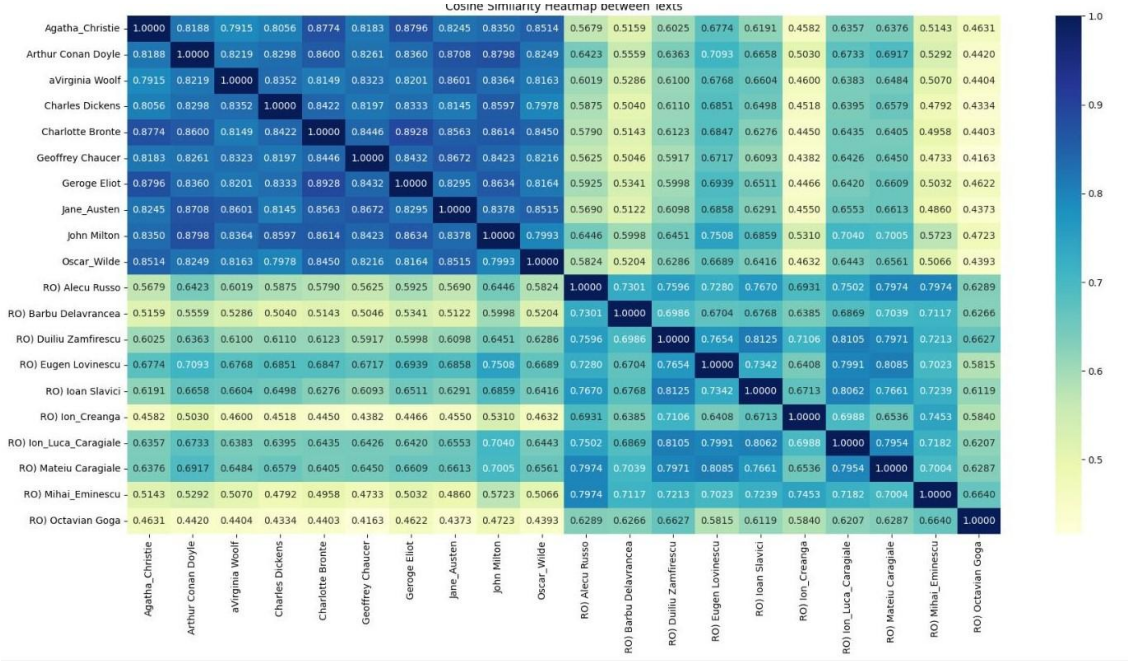

Fig. 1 – Similarity analysis using the distribution of waiting distances for letters.

Finally, we introduce a series of new large-volume domain-specific Romanian corpora to be used for AI training and show that the distribution of word frequency obeys the well-know Zipf law, despite the substantial changes in the distinct vocabularies pertaining to the domains under scrutiny. The observed scale-free distributions of word frequencies are robust across many orders of magnitude and are largely independent on how data curation and tokenization are done.

Keywords: distribution of waiting times, scale-free distributions, Zipf's law, AI training.

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30N/2023. For this work ANŻ, MCR, and PAG were partly supported by the TRUSTEE Horizon Project (Project Number: 101070214).

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S4 L2

BIOPHYSICAL CHARACTERIZATION OF CARDIAC ION CHANNEL MODULATION BY CENOBAMATE: RISK OF PROARRHYTHMIC OUTCOMES

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Cenobamate is a recently approved third-generation antiepileptic drug designed for the treatment of focal-onset seizures, especially in patients with pharmacoresistant epilepsy. Its therapeutic effects arise from a dual mechanism: positive allosteric modulation of $GABA_A$ receptors and potent inhibition of persistent voltage-gated sodium currents, contributing to neuronal stabilization and seizure suppression [1,2]. However, clinical reports have noted a shortening of the QT interval in patients treated with cenobamate, raising safety concerns regarding its potential impact on cardiac electrophysiology [3]. Given the essential role of ion channels in maintaining cardiac action potential dynamics, a detailed biophysical evaluation of cenobamate's effects on cardiac ion currents is warranted.

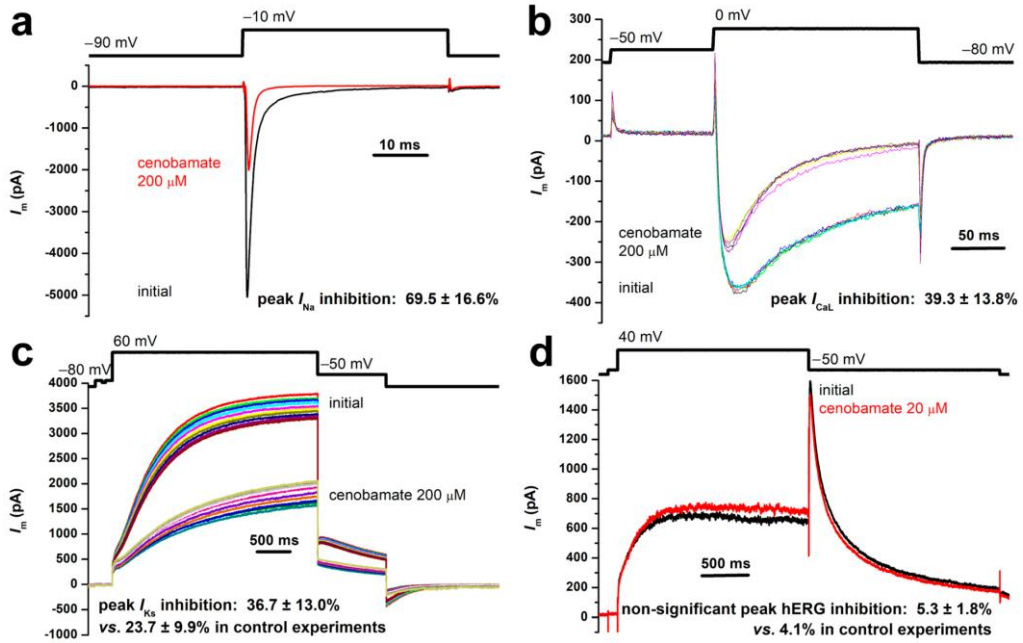

Fig.1. Biophysical characterization of cenobamate-mediated inhibition across major human cardiac ion channels. (a) Inhibition of voltage-gated sodium current (I_{Na}) recorded in hNav1.5-expressing HEK293T cells using a standard activation protocol to resolve peak and late current components; (b) Suppression of L-type calcium current ($I_{Ca,L}$) via hCav1.2 (α1c + β2 + α2δ1) channels

under step depolarization; (c) Modulatory effects on slowly activating delayed rectifier potassium current (I_{Ks}) through hKv7.1 + minK co-expression; (d) Blockade of rapid delayed rectifier potassium current (I_{Kr}) mediated by hERG (hKv11.1) channels.

In this study, we conducted an *in vitro* cardiac safety assessment using whole-cell patch-clamp recordings in HEK293T cells heterologously expressing key human cardiac ion channels: hNav1.5 (I_{Na}), hCav1.2 (α1c + β2 + α2δ1) (I_{CaL}), hKv7.1 + minK (I_{Ks}), and hKv11.1 (hERG) (I_{Kr}). Cenobamate exhibited dose-dependent inhibition of both peak and late sodium currents, as well as L-type calcium currents, with distinct potencies across ion channel types (Figure 1).

Using Ncyte® human ventricular cardiomyocytes, we further analyzed action potential dynamics and observed a marked reduction in action potential duration, indicating a potential for altered cardiac excitability and repolarization. These results highlight a biophysically relevant mechanism by which cenobamate may predispose to proarrhythmic events, particularly in compromised myocardial environments. The observed electrophysiological profile is consistent with the action of class Ib antiarrhythmic compounds, which primarily target sodium channels and modulate conduction velocity and repolarization.

Keywords: Cardiac electrophysiology, ion channel biophysics, cenobamate, proarrhythmic risk

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S4 L3

PROPERTIES AND BIOLOGICAL ACTIVITY OF COMPOSITE MATERIALS BASED ON MESOPOROUS SILICA MODIFIED WITH INORGANIC NANOPARTICLES

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The design of composite materials based on functionalized mesoporous silica nanoparticles must meet the requirements of nanomedicine for a more effective therapeutic response [1]. For instance, the application of nanoparticles-based antibacterial treatment is considered one of the most promising strategies to fight against infections caused by antibiotic-resistant bacteria. An alternative to antibiotics is the use of natural compounds recovered by extraction from plants waste [2]. Ethanolic and hydroethanolic extracts from wild bilberry leaves were prepared under inert gas pressure, conventional or ultrasounds-assisted extraction. The total content of polyphenols, flavonoids, anthocyanins, condensed tannins, as well as antioxidant and α-glucosidase inhibitory activities were evaluated by UV-vis spectroscopy, while the identification of components from the extracts was carried out by high performance liquid chromatography.

Mesoporous silica nanoparticles (MSN) are widely used as support for various bioactive substances, not only due to their ability to host organic molecules, but also for the synergistic effects on the beneficial properties, including improved chemical and thermal stability of the resulting formulations. Due to the versatility of MSN, its surface can be modified with inorganic nanoparticles (NPs) with well-known antibacterial activity such as Ag, Au, ZnO or Cu [3]. The mesoporous supports were characterized by nitrogen adsorption-desorption isotherms, FTIR spectroscopy, powder X-ray diffraction, as well as scanning and transmission electron microscopy coupled with energy dispersive X-ray analysis.

The biocompatibility of the resulting composite materials was assessed on HaCat human keratinocytes cells. All tested samples are biocompatible at doses of treatment up to 50 µg/mL. Regarding the antibacterial activity, a synergistic effect between wild bilberry leaves extract and mesoporous silica modified with inorganic NPs was observed. Encapsulated extracts proved an enhanced anti-inflammatory and antioxidant activity and could be used for topical applications.

Keywords: mesoporous silica; inorganic nanoparticles; biomedical applications.

Acknowledgements: UEFISCDI (Romania) financial support through the projects 48PED/2025 and PCE no. 117/2022 is highly acknowledged.

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S4 L4
CELLULAR RADIOBIOLOGY USING ACCELERATED IONS BEAMS AT IFIN-HH

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Hadron therapy, which employs charged particles such as protons and carbon ions, represents a cutting-edge approach to cancer treatment. The unique physical characteristics of hadron therapy—especially the Bragg peak phenomenon—allow for high precision in dose deposition, effectively targeting tumors while minimizing radiation exposure to surrounding healthy tissues [1]. This capability is particularly advantageous for complex tumors located in sensitive areas, as well as for treating radioresistant tumors that often exhibit inadequate responses to conventional radiation.

However, the advancement of hadron therapy necessitates extensive studies in radiobiology to comprehend the intricate effects of high doses of charged particles on various cellular processes. Research indicates that the biological effectiveness of hadron therapy may vary significantly based on the type of particle used and the tumor microenvironment. Moreover, integrating FLASH radiotherapy—a novel approach that delivers ultra-high dose rates (≥40 Gy/s) in a fraction of a second—with hadron therapy is expected to significantly reduce patient exposure and enhance therapeutic efficacy by minimizing damage to normal tissues while retaining effective tumor control.

Understanding mechanisms such as DNA damage responses, gene expression alterations, and the impact of tumor oxygenation is crucial for optimizing treatment protocols in hadron therapy (Kim et al., 2020; Roman et al., 2013). In this context, the ion accelerators at IFIN-HH, which include two tandem (9 MV and 3 MV) and one cyclotron (19 MeV for protons), have been adapted to deliver doses ranging from 0 to 10 Gy on biological samples (both 2D and 3D cell cultures). At the 3 MV tandem, a setup for ultra-high dose rate irradiation with protons has been implemented [2]. Specific assays for characterizing cellular responses to radiation injury, such as cytotoxicity and genotoxicity, have been developed [. Results regarding the responses of tumor and normal cells to accelerated proton irradiation are presented and discussed in light of existing literature.

In conclusion, the future of hadron therapy hinges on an interdisciplinary approach that combines innovations in radiobiology with advancements in treatment technology to provide effective solutions for challenging malignancies.

Keywords: hadrontherapy, accelerated ions beams, FLASH radiotherapy.

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S4 L5
COMPOSITE-ENGINEERED PLATFORMS FOR ANALYTICAL AND BIOSENSING APPLICATIONS

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Biosensor technology is a broad field gaining traction in the food and agriculture sectors. A crucial step in biosensor preparation is the immobilization of bio-components onto the transducer surface. The primary methods for immobilization include physical adsorption, entrapment in porous matrices (such as polymers, polyelectrolytes, or hydrogels), layer-by-layer techniques, and chemical immobilization. This lecture will outline the advantages and limitations of these methods. Significant advancements have been made in enhancing biosensor performance, including detection limits, sensitivity, and selectivity, achieved through well-designed interfaces. Innovations in material science, nanotechnology, and biomimetic design propel the biosensor field forward. Research into the use of nanomaterials in biosensor development has led to detection limits reaching the level of nM to fM, typically below the maximum levels permitted by European food legislation. Integrating biosensors into simple, inexpensive, and portable systems poses a challenge for commercially viable

biosensors and their market introduction. The future of biosensors for food quality control will undoubtedly be shaped by multi-analyte detection in multiplexed systems, the development of sensor networks, and wireless signal transmitters facilitating remote sensing.
In this context, we present several case studies and prototypes of biosensors that have been successfully applied to food safety monitoring and environmental contaminant detection. These examples illustrate the practical utility of biosensor technologies and highlight their transformative potential in supporting regulatory compliance, quality assurance, and public health protection.

Keywords: sensors, immobilization, point-of-care

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S4 L6

SUBTLE RELATIONS BETWEEN MAGNETIC COUPLING AND STRUCTURE OF POLYNUCLEAR COORDINATION COMPOUNDS

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The work deals with the structural chemistry [1] of a series of newly synthesized coordination polynuclear compounds,[2] putting on equal footing instrumental experimental data (magnetic, crystallographic, spectroscopic) and modeling aspects.

We report and debate the magneto-structural aspects in a series of Cu(II) complexes, taken as case studies. A particularly interesting situation is a hexagonal copper system, whose coupling of S=1/2 spins is quite similar to the resonance stabilization known for the benzene iconic example of aromaticity. Moreover, we have a case of four S=1/2 spins in rectangular pattern, resembling the cyclobutadiene, the prototype of anti-aromaticity (here the S=1/2 spins are stable nitroxide radicals). At this system we reached an interesting issue about uncertainties in obtaining the spin coupling parameters from experimental data (magnetic susceptibility) and the valuable support of calculations in guiding the interpretation. Thus, although the spin topology was firmly known to be a rectangle, the regular fit yielded parameters for a tetrahedral arrangement. Investigating the intriguing discrepancy, we found that in multiparametric regime the data are strongly perturbed by inherent noise in experimental measurements, making then the collateral help from computational experiments a tool for fixing a desired pattern. Within the same inquire, we observed a very interesting and practically significant clue that different computation methods may give different absolute values for exchange coupling parameters, while their ratio remain stable among different settings, being then possible to use theoretical predictions to impose relative inter-parametric proportions, simplifying the multi-parametric schemes to simpler tasks. Among the studied exchange-coupled systems we met the rare situation of conceiving new exactly solvable cases of the Spin Hamiltonian, this meaning the possibility to ascribe explicit formulas for the magnetic states and susceptibility equations, without resorting to black-box computer routines. The magnetic properties of these systems were described transparently, outlining the energy levels formulas in terms of Heisenberg exchange parameters J, within the specific topologies.

Keywords: molecular magnetism, coordination compounds, modeling.

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S4 P1

ON THE MODELING OF THE REDOX PROCESS OF FLAVONES SYSTEMS

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The 1,2-dihydroquinone fragment, succeptible for oxidative processes, is present in some biomolecules, where the electron transfer presents interest for chemistry of life and other photochemical phenomena. For instance, this group is present in flavone-type pigments, suitable for dye-senzitized solar cells [1]. In the continuation of our interest for solar cells based on various colorants deposit on TiO_2, here we consider the situation of the 3,3',4',5,7-penta-hydroxy-flavone, exchanging electrons with a silver cluster, [2] idealized as Ag_6 octahedron. The electron-deficient nature of the cluster leads to the oxidation of the phenolic groups, in a concerted two-electron process, or in a sequence of two one-electron stages. The energy profiles of these mechanisms are shown in the Figure 1.

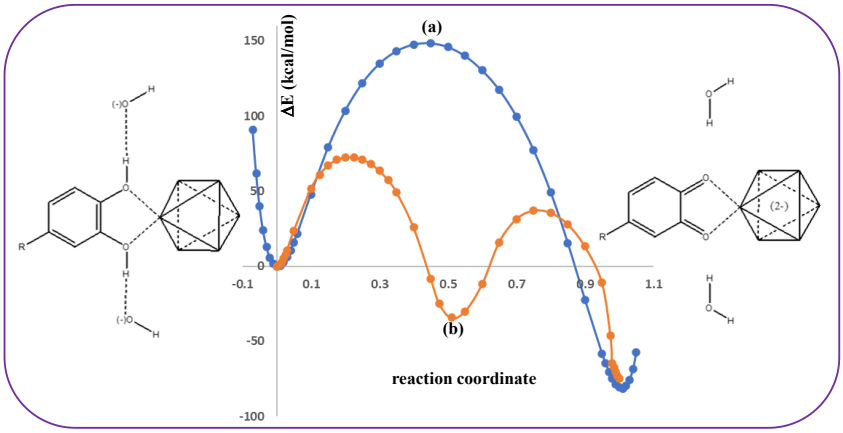

Figure 1. Potential energy profiles of different reaction scenarios: (a) one step two-electron process; (b) the two-steps of one-electron each.

The modelling is done in the frame of Density Functional Theory (DFT), with B3LYP/def2tzvp setting. Drawing the energy along the designed reaction coordinate leads to the two-well profile, with minima at x=0 and x=1 for respective reactant and products and a rather high energy barrier, of about 150 kcal/mol. To comprise the two one-electron steps within the scheme having the same start and ends as the two-electron process, we conventionally rescaled their x fractional coordinates to run between 0-0.5 and 0.5-1, respectively. One may see that the two-step process demands lower activation energies.

Keywords: density functional theory, electron transfer, flavone.

Acknowledgement: M.C.B. and A.M.T. acknowledge support from the grant PNRR-III-C9-2023 – I8 CF97/31/072023, contract no. 760283 - 27/03/2024.

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S4 P2

DISTRIBUTIONS OF WAITING TIMES IN AUTOMOTIVE TIMESERIES

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We showcase recent numerical investigations into the structure of the distribution of waiting times pertaining to synthetic automotive datasets. Using the standard definition of a waiting time, that is the shortest time interval needed to find an entry of value of at least $A+\delta$, with δ a given threshold, after a certain entry of value A was observed, and going through the entire time series we obtain the complete set of waiting times for a specific value of δ.

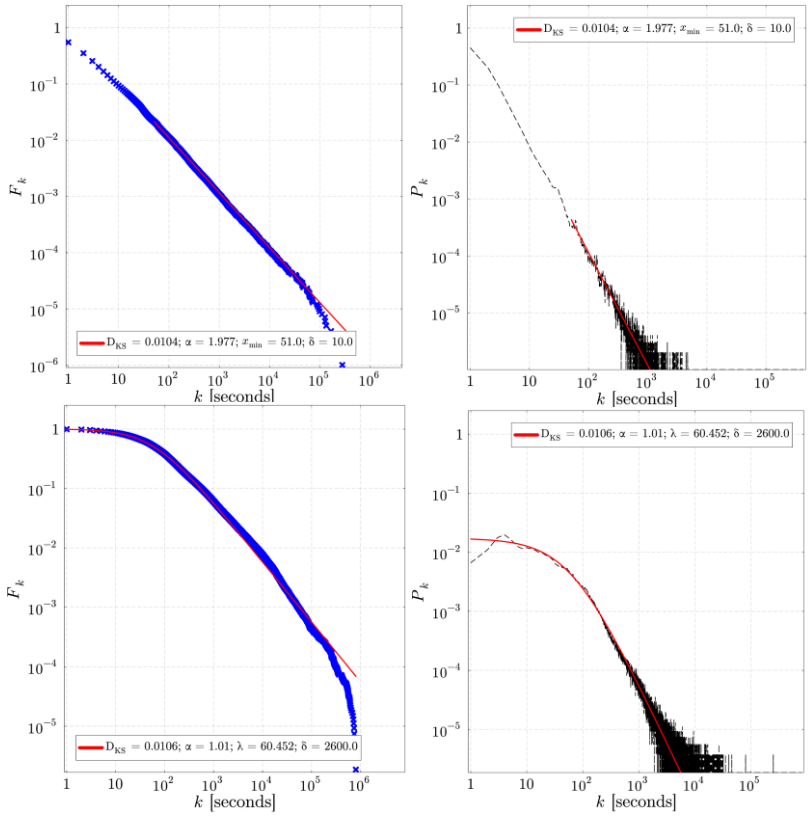

Fig. 1 Distribution of waiting times in the limit of small values of δ (upper panels) and large values of δ (lower panels), using both the probability distribution functions (right panels) and the complementary cumulative distribution function (left panels).

With this set of numerically-computing waiting times we determine the underlying distribution and show it has a prominent scale-free character for small values of δ for all indicators under scrutiny (velocity, acceleration, instant fuel consumption), while for large values of δ the observed distributions of waiting times converge to a Pareto-Tsallis distribution.

We analyze the transition from a scale-free to a Pareto-Tsallis distribution using both the Kolmogorov-Smirnov fit quality indicators and the global Kullback–Leibler divergence to understand the dynamics of the transition. Finally, we propose a series of suggestions concerning the classification of driving styles.

Keywords: distribution of waiting times, automotive data, driving styles.

Acknowledgments: This work was supported by the Romanian Ministry of Research, Innovation and Digitalization under Romanian National Core Program LAPLAS VII -- contract no. 30N/2023. For this work ANŻ, MCR, and PAG were partly supported by the TRUSTEE Horizon Project (Project Number: 101070214).

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S4 P3

TRAINING LARGE LANGUAGE MODELS ON A NOVEL ROMANIAN CORPUS

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We report here set of novel domain-specific calibrations of a large language model using a large-volume multi-domain Romanian corpus. The corpus was created using a series of custom built, automated web-scraping and extraction tools. To this end we collected more than 1 billion tokens, the underlying text being preprocessed and curated to ensure that the resulting dataset is suitable for a wide range of statistical research and AI training objectives. The data was acquired from publicly available sources spanning multiple domains of interest, including encyclopedic content, literature, news articles, legal documents, technical articles, and general web content such as blogs and forums. Encyclopedic content was sourced from the Romanian Wikipedia, while literary texts were extracted from Romanian \ Wikisource. For both of them, we used the official April 2024 Wikimedia XML dump files, publicly available at https://dumps.wikimedia.org. The dumps were processed using the open-source tool WikiExtractor, which allowed us to extract and clean the raw MediaWiki markup content into structured .json files, each containing one article per line, formatted as a JSON object with the full text as content. Each of the other domains of the corpus were also structured into .json files, a format chosen for its advantages in data streaming and efficient access during processing.

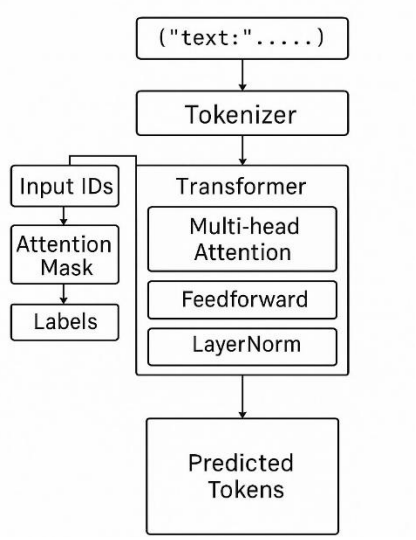

Fig. 1 – Workflow: The data is passed through a custom tokenizer to produce input IDs, attention masks, and labels. These are then fed into a Transformer architecture comprising multi-head attention, feedforward layers, and normalization, enabling the model to learn contextual representations and predict next-token sequences.

Keywords: large-volume Romanian corpus, AI training.

Acknowledgments: For this work MCR and ANŻ were supported by the Romanian Ministry of Research, Innovation and Digitalization under Romanian National Core Program LAPLAS VII -- contract no. 30N/2023.

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S4 P4

ELIMINATING ARTIFACTS IN MRI: FROM APPLYING PHYSICAL PRINCIPLES TO ACCURATE DIAGNOSTIC IMAGING

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Magnetic resonance imaging (MRI) is used frequently nowadays in diagnosis, since it is a non-invasive method that can be repeated as many times as needed to diagnose and monitor pathologies. To eliminate artifacts and improve detection sensitivity, state-of-the-art MRI systems have been implemented and applications have been developed to deal with pulse sequences, image reconstruction, and data analysis [1].

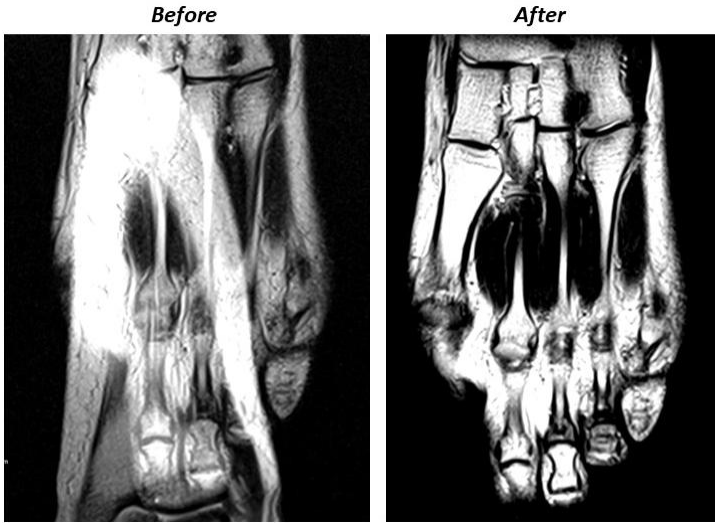

Figure 1. Wraparound Artifact in the Forefoot MRI

Even so, in some situations this is not sufficient, and it is necessary for the operator to master the physical principles underlying MRI to eliminate artifacts and obtain images that can be used in diagnosis. Also, is well known that MRI technique requires the patient to remain still during the examination, addressing artifact-related issues should be achieved in the shortest possible time. Considering these aspects, this study proposes to show how artifacts can be recognise in a short time, eliminated or reduced obtaining interpretable images. As the use of trade-off-parameters, *spatial resolution*, *signal-to-noise ratio* and *total scan time* can be challenging, this research highlights how to adjust them in a proper way to obtain images that can be used in diagnosis. For example, it can be seen from *Figure 1* that the wraparound artifact affects the image, and it cannot be fully interpreted, potentially leading to an incomplete diagnosis. In this case, changing the phase direction and using the saturation band was sufficient.

Therefore, sometimes major changes are not necessary to eliminate an artifact, but to be able to do this in a short time, it is very important to recognize the type of artifact and to know how to eliminate it. In conclusion, reduction of imaging artifacts still plays an important role in MRI investigation to obtain interpretable images even though systems have evolved, and this study contributes to this challenge.

Keywords: MRI artifacts, accurate diagnostic, MRI physics.

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S4 P5

ECO-TOXICOLOGICAL ASPECTS REGARDING PHYTOGENIC COPPER OXIDE NANOPARTICLES FOR WASTEWATER TREATMENT

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The *Green Chemistry* approaches have been used more and more in the last decade, for clean development of metal-based nanomaterials. Plant extracts are preferred in this regard for nanometal biosynthesis, because the phytochemicals present in the plant extracts are a source of reducing as well as stabilizing agents during *green* fabrication of these nanomaterials [1].

One of the valuable metal-based green nanomaterials used in many fields including wastewater treatment are phytogenic copper oxide nanoparticles (CuO NPs) [2]. This study presents a *green* approach for the phytosynthesis of CuO NPs. These nanomaterials were characterized by various physico-chemical methods. Their stability (physical and chemical) was assessed. The evaluation of the eco-impact of these nanoparticles was carried out for the purpose of the wastewater treatment applications. The effect of the obtained phytogenic CuO NPs on urease activity was evaluated by conductometric assay.

Keywords: phytogenic copper oxide nanoparticles, eco-toxicity, wastewater treatment.

Acknowledgements: The authors would like to thank the European Commission and CNCS/CCCDI-UEFISCDI for funding in the frame of the collaborative international consortium WaterGreenTreat financed under the 2022 Joint call of the European Partnership 101060874 — Water4All. This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI - UEFISCDI, project number COFUND-WATER4ALL-WATER Green Treat-1, No. 59/2024, within PNCDI IV.

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ABSTRACTS

S5 – Engineering and Industrial Physics

- *Physics of energy transfer, conversion and storage*
- *Environmental Physics*
- *Sensors and Device Physics*
- *Micro- and Nanoelectronics*
- *Microelectromechanical systems*
- *Instrumentation and Metrology*
- *Imagining, Microscopy and Spectroscopy and their applications*
- *Instrumentation, processing, fabrication and measurement technologies*
- *Applications of fluid mechanics and microfluidics*

S5 L1

THREE-DIMENSIONAL NANOWIRE NETWORKS OF BISMUTH FOR FLEXIBLE THERMOELECTRIC DEVICES

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Three-dimensional (3D) networks of interconnected nanowires (NWs) embedded within organic nanoporous templates are gaining increasing attention for the fabrication of flexible devices, especially because these nanocomposite films can be easily fabricated with modulated compositions, adjustable dimensions and complex shapes, making them well-suited for many applications, like in gas sensing scenarios [1], for micro-batteries and micro-supercapacitors [2,3], as well as in thermoelectricity [4,5].

Herein, we focus our attention on the preparation and characterization of flexible thermoelectric (TE) devices, based on such interconnected NWs made-up of pure polycrystalline Bismuth (Bi), considered as a reference TE material for harvesting thermal energy from wasted heat sources. The samples were fabricated by electrodeposition into specially-designed polycarbonate templates with crossed cylindrical nanochannels, yielding self-supported networks of Bi crossed NWs with mean diameter values ranging from 23 nm to 230 nm [4]. Hence, the evolution of structural and transport properties of these interconnected NWs as a function of their diameter was studied by means of X-ray diffraction (XRD), temperature variation of electrical resistance and TE measurements. The calculation of the Seebeck coefficient as a function of temperature and for the different diameters was performed in a configuration where the thermal gradient was applied in the plane of the nanocomposite film. In addition, we proved too, the possibility of performing transverse TE investigations on these NWs, demonstrating a large Nernst signal at room temperature.

Such hierarchical architectures relying onto Bi crossed NWs are extremely robust, offering a promising solution for the next generation of flexible TE devices, to be sustainably employed for powering-up miniaturized, low-consumption portable electronics, various wireless sensing nodes, or bio-implantable medical equipment.

Keywords: Flexible thermoelectric (TE) devices; 3D networks of nanowires (NWs); Polycrystalline Bismuth (Bi); Longitudinal and transverse thermoelectrics; Seebeck and Nernst effects.

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S5 L2

PATTERN COVARIANCE MATRIX FOR RECENT SEDIMENT DATING

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The U-Ra natural decay series provides an excellent radioisotope for recent sediment dating, namely ^{210}Pb, with a half life of 22.3 years. Provided the sample containers are efficiently sealed and the blank boxes controlled, low background sediment sample analysis can provide precious information on the supported and unsupported ^{210}Pb components after a few weeks waiting time.

Differences between those supported and unsupported fractions lead to sedimentation rate calculations following one of the three main, clear and established models (CIC, CRS and SIT). However, in case of severe changes, especially of anthropogenic origin, the results may lead to model applicability failure, or to considering the data is not valid.

To overcome this, we belive a fourth model can be applied, namely the Pattern Covariance Matrix, which considers a covariance matrix involving more than one basic model, assigning different constants to different intervals and optimizing interval length and subsequently model applicability with respect to the number of layers concerned. This is not a competing model of the SIT, but rather an optimization problem for a CIC/CRS statistic testing by layers, which includes the possibility of sediment mixing, to a reasonably low extent.

The mathematical framework is described and an example based on recent sediment cores from an area subject to human intervention a few decades ago is presented. The model limitations must however be carefully considered: besides independent time markers such as the "classic" ^{137}Cs, any records or complementary data analysis from the area must be accounted. The latter need to be compatible with the solution, either case one may obtain a perfect mixture of depositional models mathematically speaking, but which compared to the field situation would prove to be just a ridiculous matrix.

More than any prior situation, the present picture evidences the fact successfull modelling of events supposed to have led to specific activities obtained experimentally for the sequential layers is not something statistically accepted, but failed to reject.

Keywords: ^{210}Pb dating, covariance matrix, sedimentation rate, optimization model

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S5 O1

COMPARATIVE ANALYSIS OF RECYCLING PRACTICES IN THE PHILIPPINES AND ROMANIA THROUGH UTILIZATION OF RECYCLED MATERIALS

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This comparative analysis examines the recycling practices of the Philippines and Romania, highlighting both similarities and differences in their approaches to waste management. Both nations face challenges in waste management, but their strategies and outcomes differ due to varying economic, infrastructural, and policy contexts. In the Philippines, informal waste collection plays a significant role, with waste pickers recovering recyclable materials, while Romania has implemented structured systems like the Deposit Return System (DRS) to enhance recycling rates. Processed recycled materials in both countries are utilized to manufacture new products, contributing to their respective circular economies.

The Philippines generates approximately 61,000 metric tons of solid waste daily, with Metro Manila accounting for nearly 10,000 tons, and with plastic waste accounting for 24% of this total. The country has about 296 garbage disposal sites (May 2024). Rapid urbanization and population growth in the Philippines have intensified waste management challenges. The Ecological Solid Waste Management Act of 2000 (Republic Act No. 9003) was enacted to address these issues, promoting waste segregation, recycling, and the establishment of material recovery facilities (MRFs). Furthermore, The Act mandates waste segregation and promotes recycling, but challenges persist in implementation. Informal waste collectors, known as "scavengers," play a pivotal role in recovering recyclable materials, which are then sold to junk shops and recycling centers. However, this system often leads to inefficiencies and health risks for workers.

Romania, as a member of the European Union, is obligated to meet specific recycling targets. The country has faced challenges in achieving these targets, with recycling rates historically lower than the EU average. The DRS initiative has led to the collection of over 1.3 billion containers, significantly reducing waste in urban and natural areas.

Keywords: recycling Philippines, recycling Romania, MRFs,

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S5 O2

ASSESSING THE INFLUENCE OF SEISMIC ACTIVITY ON EUTROPHICATION PROCESSES IN FRESHWATER SYSTEMS: A CASE STUDY OF SIUTGHIOL LAKE AND THE WESTERN BLACK SEA COAST

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As part of the collaboration within the Competence Center for Climate Change – *Digital Twin Earth for Forecasts and Societal Redress (DTEClimate)*, funded by Romania's National Recovery and Resilience Plan, a new research question has emerged from the synergy of two component projects: **REACTIVE** (*Research Center for Climate Change Due to Natural Disasters and Extreme Weather Events*) and **Act4D-Eutrophication** (*Active Measures for Restoring Freshwater Lakes and Coastal Areas Affected by Eutrophication*).

The central question is: *Can geophysical phenomena such as earthquakes and tsunamis influence eutrophication processes in freshwater lakes and coastal waters, in addition to climatic factors?* This question is explored through a case study of **Siutghiol Lake**, located along Romania's Black Sea coast.

Siutghiol Lake, like other freshwater lakes along the western Black Sea shore, lies within the Black Sea Basin—a back-arc basin formed during the Early Cretaceous–Early Paleogene by the subduction of the Neotethys Ocean beneath the Balkanides-Pontides volcanic arc. The region is encircled by active Alpine orogenic systems including the Caucasus-Crimea, Balkanides-Pontides, and North Dobrogea–Strandja-Sakarya zones. Seismic studies have identified two major extensional sub-basins (Western and Eastern) divided by the Mid-Black Sea Ridge (Andrusov Ridge) - after Diaconescu et al, 2019a and 2019b.

The test site is influenced not only by local crustal seismic sources but also by the intermediate-depth seismic zone of Vrancea. Historically, the Black Sea region has experienced 22 tsunami events, posing potential geohazards to nearby ecosystems. In extreme scenarios, such events could affect lake eutrophication by damaging critical infrastructure—such as the breach of dams between the Danube–Black Sea Canal and Siutghiol Lake, destruction of the nearby Rompetrol refinery, or saltwater intrusion from a tsunami.

While these events represent low-probability, high-impact scenarios, they highlight the importance of integrating geophysical risks into eutrophication and climate resilience studies.

Keywords: seismic hazard, tunami hazard, eutrophication

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S5 O3

DRIVING INNOVATION: THE EUROPEAN DIGITAL INNOVATION HUB IN TRANSYLVANIA, MISSION FOR A GREEN AND DIGITAL FUTURE

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Transilvania DIH's mission is to address industry and societal challenges through innovation driven by digital technologies. We use cutting edge technologies like AI, HPC and Big Data to enable digital transformation processes, provide green/sustainable solutions that improve productivity, competitiveness, growth, and wellbeing at regional, national, EU, and international levels. Transilvania DIH's general objective is to provide a complete set of digital transformation and innovation services for (1) SMEs and (2) public sector organizations (PSOs) conducting non-economic activities from the NW region of Romania and, through the EDIH network, at EU level. TDIH's primary specialization and services use AI, HPC and Big Data to support the green and digital transformation of SMEs and PSOs in the fields of Digital Health and Industry 4.0, leading to economic development, competitiveness, and societal progress.

TDIH is based on a 3-phase process: Understand > Innovate > Scale, and 2 alternative Client Journeys (Minimal and Optimal) through which we will provide significant innovation and digital transformation services.

We will provide knowledge and technological transfer from research to the market by services: Testing/validation for software applied in energy; Testing components and equipment for energy efficiency and green buildings; Access to specialists; Training in the fields of energy transition and digitalization in energy.

This work is funded by Innovation 2022-2027, project PN 23 24 02 01, Romania and Digital Europe Programme, TDIH DIGITAL-2021-EDIH-01, no. 101083508.

Keywords: energy, digitalization, innovation, technological transfer

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S5 P1

COMPOUND EVENTS IN ROMANIA (1951-2024)

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Compound events (CEs) are intricate weather and climate phenomena resulting from the interplay of multiple hazards (e.g., precipitation, drought). Their combined effects intensify societal and economic consequences, making them more devastating than individual hazards. Due to their compounded nature, these events can lead to greater damage and higher fatality rates. In this study, we focus on multivariate events, which appear when two or multiple hazards interact in the same location and at the same time. Using CETD (Compound Events toolbox and Dataset), a global compound events detection, we have identified regions in Romania that are vulnerable to extreme events. Utilizing observations, reanalysis, and model simulations, CETD assesses the frequency, duration, and intensity of various types of compound events, including multivariate, temporal, and spatial occurrences. The CETD uses data from different databases, including ERA5, which is a high-resolution database, with a horizontal resolution of 0.25x0.25°. In this study, daily maximum temperature, total precipitation, mean surface wind speed, and mean wind speed at 500 hPa were extracted from ERA5 reanalysis dataset obtained from the Copernicus Climate Change Service (C3S) Climate Data Store (CDS) for the period 1951-2024. We selected seven hazard pairs: hot and dry, hot-dry-stagnation, hot-dry-windy, hot and stagnation, hot and wet, hot-wet-stagnation and hot-wet-windy. They were defined as: hot (≥95th percentile), dry (<5th percentile), wet (≥95th percentile), windy (≥95 percentile) and stagnation - daily mean wind speed at near-surface level (sfcWind<3.2 m/s) and preWind500 : daily mean wind speed at 500 hPa pressure level (preWind500 < 13 m/s.). Stagnation events are characterized by low wind speeds that can lead to reduced air circulation and can amplify air pollution and pose risks to human health and ecosystems. We analyzed the spatial distribution and temporal changes for each CEs, thus identifying hotspots for their occurrence. The results indicate that certain regions in Romania are highly susceptible to multiple compound events (CEs), with their frequency showing a significant upward trend over recent decades. Identifying these vulnerable areas is vital for guiding future planning efforts, implementing risk reduction measures, and developing adaptation strategies to address the challenges posed by climate change. Using different models, we simulated from 2025 to 2060 the total duration of compound events. According to the models, some regions in Romania may be vulnerable to extreme events in the future.

Keywords: compound events, hazard, risk

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S5 P2

TOMOGRAPH SYSTEM FOR EXTRA-LONG SAMPLES

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Commercial industrial computed tomography (CT) scanners are invaluable tools for non-destructive X-Ray inspection. While they are well suited for samples of regular sizes and in some cases even for long samples of up to 1 meter, they are limited when it comes to scanning extra-long samples. Commercial CT scanners are typically designed for usual regular sample sizes, have a predefined maximum sample length and width that they can accommodate, and cannot be used for extra-long samples because of the restrictive physical dimensions of the shielded cabinet and limitations in the mechanical configuration. Lately there has been a demand for analyzing extra-long samples, that can have a size of up to 3 meters, where such samples can be sections of superconductor cables or drill cores extracted from drill sites.

In our laboratory we designed and developed a custom versatile high-power micro-tomograph that can provide high penetrability while achieving resolutions down to 3 µm. The 320 kV X-ray generator allows for a wide range of samples types, densities and sizes to be analyzed. We use different motorized high-precision / high load axis and multiple X-ray detectors types for various experimental setups, with a flexibility that cannot be matched by regular commercial X-ray systems. Thanks to the 4 meters long shielded cabinet, we are able to accommodate samples of up to 3 meters long.

This paper presents results and limitations of the experimental setup used for scanning such a sample and a custom frame solution, designed to overcome these limitations. The frame can support the 320 kV X-ray tube, a 400 x 400 mm flat panel detector and a 100 kg load motorized rotation stage. The detector can be mounted on the same base as the X-ray tube and both can travel on linear guides up to 1450 mm along the length of the sample. Motorized movement of the base is achieved by means of a ball screw.

Keywords: X-ray, tomography, extra-long samples

S5 P3

RAMAN AND FTIR STUDY OF GRAPHENE-BASED MATERIALS FOR ELECTROMAGNETIC SHIELDING

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In the pursuit of advanced materials for electromagnetic shielding, carbon-based systems decorated with metal oxides have attracted significant attention due to their synergistic combinations of conductivity, dielectric properties, and structural versatility. This work presents a detailed spectroscopic analysis - via Raman spectroscopy and Fourier-transform infrared (FTIR) spectroscopy - of graphite (G), graphene oxide (GO), and reduced graphene oxide (RGO) used as precursors for the synthesis of hybrid carbonaceous-metal oxide composites.

The structural evolution from graphite to GO and RGO was systematically investigated to understand the degree of functionalization, defect introduction, and restoration of sp^2 carbon networks critical for subsequent metal oxide nucleation. Raman spectroscopy (Fig. 1) provided insight into disorder-induced D-band intensity variations, G-band shifts, and the ID/IG ratios, revealing the progressive oxidation of graphite into GO and the partial recovery of graphitic domains in RGO. Complementary FTIR analysis enabled the identification of oxygenated functional groups (e.g., hydroxyl, epoxide, carbonyl, and carboxyl moieties) that facilitate metal oxide anchoring, and tracked their reduction following chemical treatment.

The spectroscopic signatures obtained were correlated with the materials' potential to act as effective platforms for uniform metal oxide deposition, a prerequisite for optimizing electromagnetic ecranation performance. Preliminary results indicated that the controlled defect density and functional group distribution in RGO provide the active sites for metal oxide growth.

This study emphasizes the important role of spectroscopic characterization in tailoring the chemical and structural properties of carbon precursors for next-generation shielding materials.

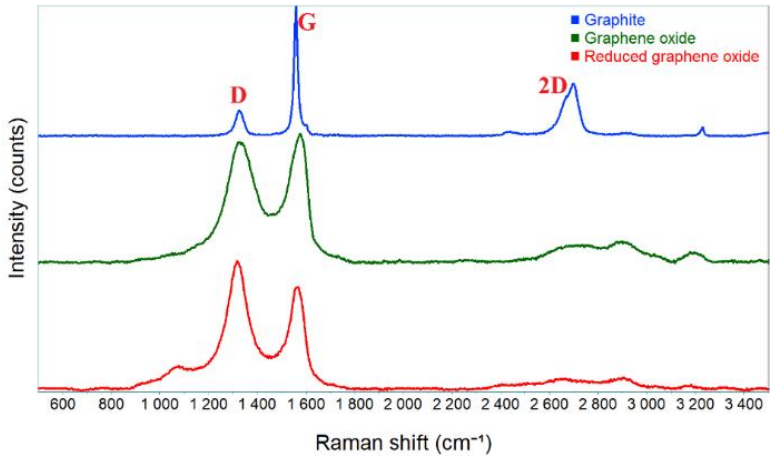

Figure 1. Raman spectra of graphene-based materials

Keywords: Graphene, Raman spectroscopy, FTIR spectroscopy

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S5 P4
FABRICATION AND CHARACTERIZATION OF $CuBi_2O_4$ SPINEL ABSORBER LAYER FOR ALL-OXIDE PHOTOVOLTAIC CELLS

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At present, inorganic semiconducting materials are the most economical and viable source for the renewable energy industry. Also, an old branch of photovoltaics is being revived through all-metal-oxide photovoltaics. This work deals with the morphological and optical characterization of p-type copper oxide (CuO) and bismuth oxide (Bi_2O_3) through spinel formation into $CuBi_2O_4$, and other oxides such as: zinc oxide (ZnO), nickel oxide (NiO) thin films fabricated by succesive pulsed laser

deposition (PLD) on indium-tin oxide (ITO) pre-coated glass. The above inorganic composite materials can be applied in photovoltaic cells, currently with moderate performances. An attempt has been made to study structural, morphological and absorption characteristics of individual films and the final structure using state of the art techniques like X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM) and UV-Vis spectroscopy. The energy band gaps of resulting oxides have also been calculated and discussed based on the UV-Vis spectroscopy measurements.

New ways of manufacturing solar cells that can scale-up to large volumes and low cost are required; here, the widely available transition metal oxide based materials can play a decisive role due to their low cost and simple scale-up to large volume production. Futhermore, this work attempts to simplify fabrication through the use of just one fabrication step (PLD) for all oxides.

Keywords: all-oxide photovoltaics, PLD, thin films, spinel.

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S5 P5

NANOCRYSTALLINE LANTHANUM PEROVSKITE AS CATALYST FOR COMBUSTION OF SOME VOLATILE ORGANIC COMPOUNDS

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Catalytic combustion at low and medium temperature is used to remove polluting gases from the air, volatile organic compounds (VOCs) such as solvent vapors, mine gases, combustible gases escaped from industrial installations etc.

The nanocrystalline lanthanum perovskite $LaFeO_3$ were synthesized by a combined sol-gel and self-combustion method and heat treatment. The perovskite structure of the material, without secondary phases, was obtained at a calcination temperature of 900 ºC/40 min. The lanthanum perovskite powders, obtained by this procedure, was studied from a morphological and structural point of view by TG-DTA, XRD, SEM-EDX, BET and XPS analyses. Also, the powder was studied from the point of view of catalytic activity in the temperature range 50 – 550 ºC for a series of volatile organic vapors diluted with air, acetone (C_3H_6O), toluene ($C_6H_5CH_3$) and xylene ($(CH_3)_2C_6H_4$).

The degree of conversion increases substantially in a narrow temperature range (200 – 270 ºC) and reaches values of over 99% for acetone vapor. Close values of the degree of conversion are also obtained in the case of toluene, but at much higher temperatures (340 – 350 ºC). The lowest catalytic

activity was obtained in the case of xylene where the degree of conversion can reach a value of 88% at temperatures around 500 ºC. The catalyst based on this perovskite obtained by the preparation method used by us can be recommended for the combustion of acetone vapors. Regarding acetone, the catalytic activity of this catalyst is remarkable and approaches that of a catalyst that includes noble metals in its structure.

Keywords: perovskite, structural properties, catalysts, volatile organic compounds.

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S5 P6

FAST AND SENSITIVE DETECTION OF PESTICIDES IN WATER USING A FIBER-OPTIC SURFACE PLASMON RESONANCE SENSOR

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The extensive use of pesticides in agriculture has led to increasing concerns over the contamination of water resources, posing significant threats to both human health and aquatic ecosystems [1]. Traditional laboratory-based analytical methods, such as gas chromatography and mass spectrometry, while accurate, are time-consuming, expensive, and unsuitable for in situ or real-time monitoring. To address these limitations, we report the development of a fiber-optic surface plasmon resonance (FO-SPR) sensor capable of rapid, sensitive, and selective detection of various pesticides in water [2].

The proposed sensor design employs a multimode optical fiber coated with a thin layer of gold, serving as the plasmonic medium [3]. The sensing region is further functionalized with a molecular recognition element, such as a self-assembled monolayer or polymers, to enhance specificity toward target pesticide molecules, including 4-nitrophenol, 2,4-dinitrophenol, thiram, etc. When the target analyte binds to the recognition layer, it induces a change in the refractive index at the metal-dielectric interface, leading to a measurable shift in the resonance wavelength of the FO-SPR signal [4]. Experimental validation demonstrates the sensor's capability to detect pesticides at concentrations as low as 1nM, with high selectivity against common interfering substances. In addition, the compact, portable design makes it well-suited for deployment in field settings, offering a practical solution for real-time water quality assessment.

This work underscores the potential of fiber-optic SPR sensors as powerful analytical tools for environmental monitoring. Their combination of sensitivity, specificity, and portability provides a compelling alternative to conventional detection methods, particularly in remote or resource-limited

regions. Ongoing efforts focus on multiplexing capabilities and integration with wireless communication modules for broader environmental sensing applications.

Keywords: pesticides, plasmonic materials, fiber optic-based sensors, environmental monitoring.

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S5 P7

ROOM-TEMPERATURE HYDROGEN SENSING WITH POLYANILINE CHEMIRESISTORS

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Hydrogen (H_2) plays a critical role in various industrial and energy applications due to its high energy content and clean combustion. However, its high flammability and low ignition energy necessitate the development of sensitive, reliable, and low-power hydrogen sensors for safe handling and leak detection [1]. This study explores the chemiresistive properties of polyaniline (PANi), a conductive polymer, for H_2 sensing at room temperature. PANi's intrinsic electrical conductivity, stability, and tunable surface chemistry make it a promising material for gas sensing under ambient conditions [2].

In this work, thin films of PANi were synthesized using a chemical oxidative polymerization method and subsequently deposited on gold interdigitated electrode substrates to fabricate chemiresistive H_2 sensors. The sensing mechanism is based on the change in electrical resistance of PANi upon exposure to H_2 gas, attributed to interactions between hydrogen molecules and the polymer's nitrogen sites. These interactions lead to changes in charge carrier concentration within the polymer matrix, resulting in measurable resistance variations [3].

The fabricated PANi sensors were tested at room temperature under varying concentrations of H_2 ranging from 1 ppm to 1000 ppm. The sensors exhibited a fast and reversible response and their sensitivity was found to increase with higher H_2 concentrations, demonstrating a clear and repeatable trend. The results highlight the potential of PANi-based chemiresistors as low-cost, energy-efficient, and room-temperature-operable H_2 sensors. Such sensors can be readily integrated into safety systems in fuel storage, hydrogen-powered vehicles, and industrial settings. Future work will focus on

improving sensitivity and selectivity through doping, composite formation, and microstructural optimization.

Keywords: hydrogen sensing, chemiresistive sensor, polyaniline, chemical oxidative polymerization.

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S5 P8

TEMPERATURE AND VAPOR PRESSURE BEHAVIOR OF 1-µL DROPLETS

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In a recent study, a new method for measuring the temperature of droplets with microliter volumes was validated [1]. The method implies an optical fiber-based (FBG) temperature sensor and relies on monitoring the vapor layer temperature near the droplet at sub-millimeter fiber-to-droplet distances. During the validation measurements of the method, an image acquisition system was used to correlate the measured temperature with droplet volume (V) and fiber-to-droplet distance (D), determined through images analysis. Simultaneously, during droplet evaporation and depending on the relative humidity (φ) in the enclosure, optical fiber displacements were observed. Here, for V=1 µl (1.24 mm diameter), temperature variations as a function of droplet content (dopant) and vapor pressure effects correlated with temperature regimes are reported.

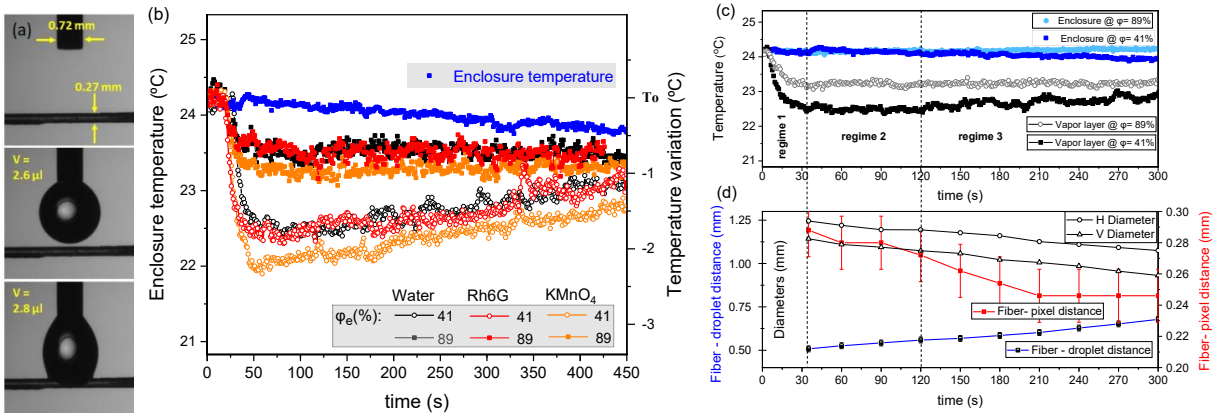

Fig.1 (a) Pendant droplet – fiber sensor system. (b) FBG sensor response to different droplet dopants (water, Rh6G, $KMnO_4$) for two relative humidities levels (φ) in the enclosure. (c) Evolution of the

water vapor layer temperature for D= 0.050 mm. (d) Effects of vapor pressure on the optical fiber correlated with temperature regimes, namely: fiber-to-droplet and fiber-to-fixed pixel distances, as well as horizontal and vertical droplet diameters for φ= 41% case; in (c) and (d), dashed vertical lines indicate the evolution of distances correlated with temperature regimes; in (d), the distance measurement error (±17 μm) is shown to scale for both Y axes.

Using the implemented FBG temperature sensor method, we observed droplet temperature variations as a function of the dopants' heating capacity (C) and concentration (c), specifically between Rhodamine 6G (Rh6G; C=560 J/mol K, c= 5×10^{-4} M) and Potassium permanganate ($KMnO_4$; C=119.2 J/mol K, c= 1×10^{-3} M) droplets. In addition, through images analysis and using a damage pixel of the CCD camera as a fixed reference point in the image, virtually, placed between fiber and droplet, we were able to evaluate the fiber displacements induced by water vapor during 1-μl droplet evaporation.

Keywords: FBG sensor, droplet and vapor layer temperatures, vapor pressure

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S5 P9

CHEMIRESISTIVE SENSING OF METHANE USING A TAILORED SnO_2:ZnO NANOCOMPOSITE MATERIAL

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Methane (CH_4) is a highly flammable greenhouse gas commonly encountered in mining operations, oil and gas industries, and agricultural environments. Its effective detection is essential for both environmental protection and industrial safety [1]. In this work, we present the design, fabrication, and performance evaluation of a chemiresistive gas sensor based on a mixed metal oxide composite of tin dioxide (SnO_2) and zinc oxide (ZnO) for the selective and sensitive detection of CH_4.

The SnO_2:ZnO nanocomposite material was synthesized onto an alumina substrate with interdigitated platinum electrodes using the pulsed laser deposition (PLD) method [2], followed by controlled thermal annealing at 450°C to enhance crystallinity and phase stability. The target used for depositions by the PLD technique was prepared in our laboratory, consisting of a 3:1 ratio of SnO_2 to ZnO, both in molar and atomic proportions. The physico-chemical analysis and morphological characterization using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS), respectively, confirmed the successful formation of a homogenous and well-dispersed nanocomposite. The

heterojunctions formed at the interface between SnO_2 and ZnO are expected to play a critical role in enhancing gas sensing performance by modulating electron transport and increasing surface reactivity. Gas sensing experiments were carried out in a controlled chamber over a concentration range of 1–1000 ppm CH_4 and operating temperatures between room temperature and 350°C. The improved sensing performance is attributed to the synergistic interaction between SnO_2 and ZnO, which enhances oxygen ion adsorption and facilitates methane oxidation reactions on the surface [3].

These results highlight the potential of mixed SnO_2:ZnO metal oxide composites as promising candidates for practical, low-cost CH_4 sensors in safety-critical and environmental monitoring applications. Ongoing work includes sensor miniaturization, long-term stability tests, and integration with wireless modules for real-time remote sensing capabilities.

Keywords: methane sensing, chemiresistive sensor, metal oxides, nanocomposite materials.

Acknowledgments*:* This research was supported by the National Authority for Research and Innovation in the framework of the Nucleus Programme—LAPLAS VII (grant 30N/2023) and by the grants of the Ministry of Research, Innovation and Digitalization, CNCS/CCCDI- UEFISCDI, project no. 19PCE/2025, PN-IV-P1-PCE-2023-1902 and project no. 72/2024, ERANET-M-3-GasSensingMat-RT-1, within PNCDI IV and PoCIDIF nr. 390008/27.11.2024.

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S5 P10

COMPARISON BETWEEN OBSERVED AND INSTRUMENTAL SEISMIC INTENSITY FOR ROMANIAN EARTHQUAKES

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Macroseismology (including historical seismology) is the non-instrumental part of the seismology and taking into consideration that the first descriptions of the earthquake effects are a few millennia old, it is considered the oldest method of studying earthquakes (Cecić and Musson, 2004; Constantin et al., 2023). The fundamental components of macroseismology research is the so called "macroseismic intensity data" which describes the level of damage caused by an earthquake in different places and quantifies their impact. The usual procedure of application the macroseismic scale for assessing the seismic intensity requires some extra time to collect from the field all the information about the earthquake effects. The felt intensity values, are often presented in the form of macroseismic maps or isoseismal maps for significant seismic events. In case of necessity for fast estimation of seismic intensity, it is used the available instrumental records for felt earthquakes, obtained from seismic network. In presently, with strong motion recorders being increasingly widespread, it has become possible to compare and correlate the observed felt intensity with intensity deduced from the instrumentally records (Constantin et al., 2021a si 2021b). In addition, the ability to correlate macroseismic intensity, often based on subjective reports from people affected by the earthquake, with instrumentally intensity from peak ground acceleration (PGA) can offers more precise and reliable assessments of seismic impact.

In this study, we have selected the strong motion records (i.e., the PGA), obtained in Romania in the last three years for a set of 5 significant earthquakes where there is a matching macroseismic maps available, and compared the intensity values at the each location to instrumentally derived intensity from the same recorder site.

Using all type of available data is a problem of significant importance during the occurrence of significant to strong earthquakes when urgently decisions to help the population in the affected zones have to be taken.

Keywords: Macroseismic intensity, peak ground acceleration (PGA), isoseismal maps, ShakeMap

Acknowledgements: This work was carried out within Nucleu Program SOL4RISC, supported by MCI, project no PN23360201, and PNRR- DTEClimate Project nr. 760008/30.12.2022, Component Project Reactive, supported by Romania - National Recovery and Resilience Plan.

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S5 P11

THERMOELECTRIC SENSORS FOR OPHTHALMIC SURGERY

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Currently, during ophthalmic surgery irrigation fluid temperature, intraocular temperature (IOT), and ocular surface temperature (OST) are usually not monitored. Standard surgery is accompanied by artificial uncontrolled deep hypothermia of intraocular structures with their subsequent rapid warming, which can be dangerous for retinal tissues. The study aimed to explore the possibility of using thermoelectric sensors for perioperative monitoring of ocular heat transfer in ophthalmic surgery.

Thermoelectric devices were developed to measure ocular surface temperature (OST), heat flux (HF) density, and intraocular temperature (IOT) [1,2].

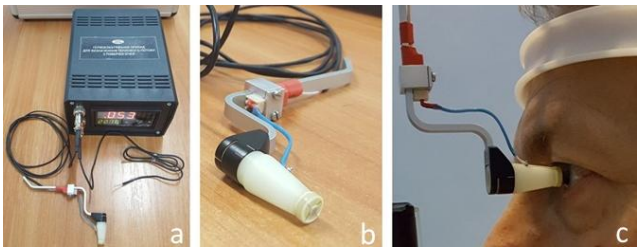

Figure 1. The thermoelectric device for determining the OST and HF density of the human eye. (a) Electronic control unit; (b) a thermoelectric HF sensor, located between two ceramic plates (3 mm in diameter); (c) Thermoelectric HF sensor in contact with the central area of the cornea [1,2].

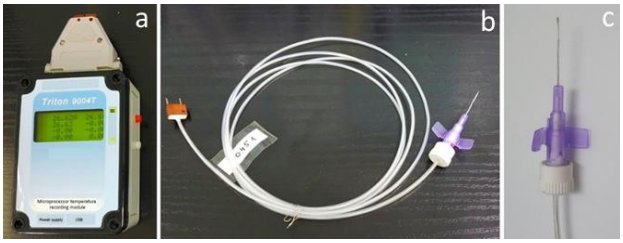

Figure 2. The thermoelectric device for measuring IOT. (a) microprocessor module for temperature data logging; (b) flexible thermocouple measuring probe; (c) measuring probe in a conventional polytetrafluoroethylene cannula housing (the outer diameter is 0.6 mm; its length is 19 mm) [2].

This pilot, open-label, prospective study included 23 patients (23 eyes) with proliferative diabetic retinopathy in both eyes. All patients underwent standard vitreoretinal surgery with IOT monitoring, pre- and postoperative measurements of HF density and the OST. This study demonstrated the possibility of using developed thermoelectric devices for comprehensive perioperative monitoring of ocular heat transfer in vitreoretinal surgery. The sensors used to measure IOT, OST, and HF density were safe and effective throughout all stages of ophthalmic surgery. Confirmation of the benefits of comprehensive perioperative temperature monitoring in ophthalmic surgery and implementation of this technique in surgical practice requires further targeted research.

Keywords: temperature sensor; heat flux sensor; ophthalmic surgery.

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S5 P12

THERMOELECTRIC COOLING AND HEATING FOR TEMPERATURE MANAGEMENT IN OPHTHALMIC SURGERY

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Currently, intraocular surgery is widely used in ophthalmology. Typically, the irrigation fluid used for surgery is at room temperature, i.e., significantly lower than the temperature of the intraocular media. Standard vitreoretinal surgery involves artificial uncontrolled (often prolonged) deep hypothermia of the intraocular structures followed by rapid uncontrolled warming after the cooling stage. Rapid uncontrolled changes in intraocular temperatures pose a risk of retinal damage, as well as the occurrence of undesirable vascular reactions during surgery.

The study aimed to determine the optimal energy and temperature conditions for the cooling (heating) of irrigation fluid by thermoelectric devices and to study the parameters of a highly efficient thermoelectric device for controlling the temperature of irrigation fluid during ophthalmic operations.

Previous studies indicate the feasibility of using for surgery an irrigation fluid with a temperature of 32–35 °C, which is higher than the ambient temperature and several degrees lower than the intraocular temperature, to maintain intraoperative conditions of mild or moderate intraoperative hypothermia [1,2]. Short-term deep cooling of the intraocular media by lowering the temperature of the irrigation fluid to 10–15°C may be useful in some situations during surgery, for example, when stopping intraocular bleeding. The listed parameters were used in computer simulation, which was carried out in the Comsol Multiphysics software environment.

Computer modelling showed that it was sufficient to provide about 6.6 W of cooling capacity to achieve a fluid temperature at the outlet of the cooling unit of about 0 °C (Fig. 1). The coefficient of performance in this case reached 0.6. The length of the polymer tube from the cooling unit to the cannula was 300 mm.

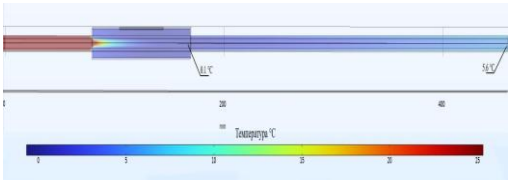

Figure 1. Change in coolant temperature during thermoelectric cooling.

The possibility of fulfilling both medical and technical requirements for achieving the required temperature of the therapeutic irrigation fluid using thermoelectric equipment has been theoretically and experimentally confirmed. The use of a powerful thermoelectric cooling module significantly reduces the time to reach the required fluid temperature. Liquid cooling of the hot side of the thermoelectric module helps to reduce the required level of cooling capacity to achieve a fluid temperature of about 9 °C. The temperature of the fluid at the outlet of the thermoelectric unit is easily regulated by the supply current of the thermoelectric cooling module. To quickly reach the required temperature of the therapeutic irrigation fluid (less than 5 minutes), it is advisable to use a higher power supply of the thermoelectric module at the beginning of the procedure with its subsequent

reduction. The use of a fluid temperature controller and autonomous fluid heat removal simplifies the operation technology of the thermoelectric cooling unit.

Keywords: thermoelectric medical device, ocular surface temperature.

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S5 P13

METHODS AND EQUIPMENT FOR MEASURING OF THERMAL RESISTANCE OF CONTACT STRUCTURE FOR THERMOELECTRIC ENERGY CONVERTERS USING THE COMPLEX ABSOLUTE METHOD

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One of the tasks of modern thermoelectricity is the miniaturization of thermoelectric energy converters, which will significantly reduce the cost and expand the possibilities of their practical use. The main obstacle to this is the relatively large values of contact resistance, since, as is known, the influence of contact resistance on the efficiency of a thermoelectric energy converter increases as it becomes miniaturized [1]. This paper proposes a method for determining the thermal resistance of contact structures for thermoelectric energy converters, which is based on the absolute method of measuring thermal conductivity [2, 3].

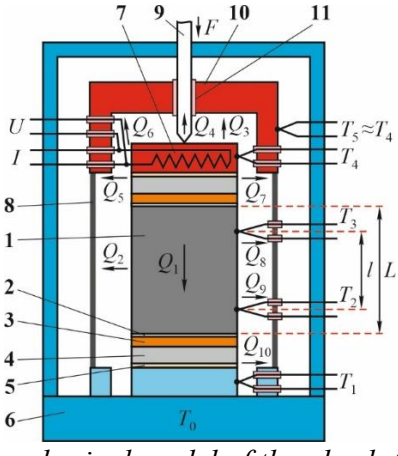

Fig.1. The physical model of the absolute method for measuring the thermal contact resistance

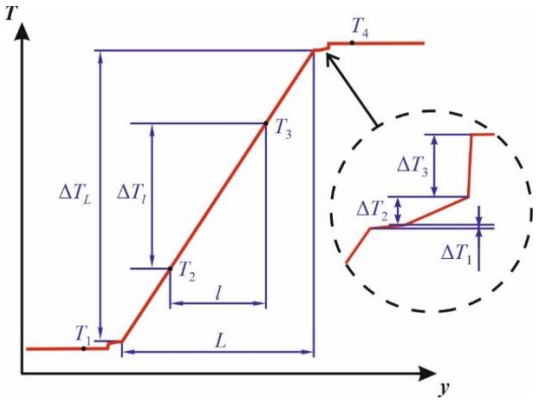

Fig.2. Temperature distribution along the axis of the studied contact structure

The detailed physical model of the absolute method is shown in Fig. 1. It includes a sample of thermoelectric material 1 with metal coatings 2 applied to its end surfaces, metal plates 3, ceramic contact plates 4, transitional contact layers 5, a thermostat 6, a reference heater 7, as well as thermocouples $T_1 – T_4$; $Q_1 – Q_{10}$ – heat loss from the surface of the sample and the reference heater.

Temperature distribution along the axis of the studied contact structure is shown in Fig. 2. Thermal resistance of the contact structures determined using the formula:

$$R_T = \frac{1}{2}\left[(T_4 - T_1) - \frac{L}{l}(T_3 - T_2)\right]\frac{S}{W}.$$

As demonstrated by computer modeling, the primary source of errors in determining both the thermal conductivity of the sample material and the thermal resistance of contact structures is heat loss due to radiation. It has been determined that by selecting optimal values for the emissivity of the elements in the physical model, these errors can be reduced to 0.7% – 3.4%.

These results formed the basis for the modified design of the measuring unit of the ALTEC-10001 equipment, developed at the Institute of Thermoelectricity (Ukraine).

Keywords: thermoelectricity, thermal contact resistance, measurement, accuracy.

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S5 P14

THERMOELECTRIC DEVICES FOR OCULAR COOLING

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Local artificial hypothermia of the eye can be beneficial for reducing the negative effects of ischemia and inflammation on ocular tissues in various ophthalmological pathologies. The study aimed to develop a design and manufacture experimental samples of thermoelectric medical devices for contact and non-contact cooling of the eye. Experimental samples of thermoelectric medical devices for ophthalmology were engineered, which allow for controlled artificial cooling of the eye in three different ways: by contact technique directly through the cornea of an open eye; by contact technique through the eyelids of a closed eye; and also by cooling the open eye by a contactless technique.

Fig. 2. Appearance of the device for contact cooling of the eye. Thermoelectric electronic cooling, control and power unit with cooling liquid heat exchanger [1].

Fig. 3. Appearance of the thermoelectric medical device for contactless cooling of the eyes. Electronic control and power supply unit with thermoelectric cooling module [1].

At the subsequent stage, an experimental study was conducted. The experiment established that artificial contact 10-minute heat dissipation from the rabbit eye with a constant temperature of the cooling surface of the developed thermoelectric medical devices at 10 °C directly through the cornea is accompanied by a decrease in the temperature of the ocular surface by 7.1 °C; contact cooling of the eye through closed eyelids by 4.4 °C; and with contactless cooling it is by 1.4 °C compared to the initial data, which allows achieving a potentially therapeutic level of hypothermia of the eye structures and creates the prospect of using the beneficial properties of artificial local hypothermia in ophthalmology.

Keywords: thermoelectric medical device, ocular surface temperature.

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S5 P15

THERMOCOUPLE WITH ADVANCED LATERAL HEAT EXCHANGE

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The development of thermoelectric technologies plays a key role in increasing the efficiency of energy conversion systems, especially in conditions of autonomous power supply and utilization of waste heat [1]. One of the promising areas for improving thermoelectric devices is the optimization of the design of thermoelements, which ensures an increase in their energy efficiency. In particular, an important factor is heat exchange on the side surfaces of the thermoelement, which can significantly affect the temperature distribution and operating characteristics of the device [2]. Recent studies show [3] that modifying the geometry and thermal conditions on the side surfaces of the thermoelement allows you to control the heat transfer processes, which, in turn, affects the thermoelectric efficiency.

This work conducted a computer study of a thermoelement with developed side heat exchange. For this purpose, a 3D physical model was developed, a mathematical description of the processes of thermal conductivity and electrical conductivity was constructed, and numerical analysis was implemented using the Comsol Multiphysics software package.

Using Comsol Multiphysics made it possible to create and study a 3D computer model of a generator thermoelement. The dependences of efficiency, electric power, voltage on the coolant flow

rate in the channel, and the height of the branches were found. Thus, for the parameters of the thermoelectric material based on Bi-Te, the proposed generator thermoelement at a gas temperature of 600K gives an EMF value of 0.012 V, a voltage of 0.006 V at a current of 0.0067 A, and an electric power of 4.5 10-5 W. At the same time, the coolant temperature at the outlet of the thermoelement is 534.7 K. The efficiency of the thermoelement is 0.52%.

The results obtained allow us to assess the effectiveness of various design solutions and formulate recommendations for optimizing thermoelements for generating electrical energy from waste heat from vehicles and various thermal wastes from power plants.

Keywords: thermoelectric element, electric power, computer design, energy efficiency.

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ABSTRACTS

S6 – Topics in Physics Education Research

- *Physics curriculum design*
- *Active learningtechniques*
- *Classroomteaching, demonstrationsandlaboratoryexperiments*

S6 O1

WHY NEED FOR MORE PHYSICS CURRICULUM DESIGNS? THEY ARE ALREADY THERE: A COMPARATIVE ANALYSIS OF IBDP, A-LEVEL, AND AP PHYSICS CURRICULA

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[1]*Babes-Bolyai University, Faculty of Physics, Cluj-Napoca, Romania*

This talk will show a comparative analysis of three prominent pre-university international physics curricula: the International Baccalaureate Diploma Programme (IBDP) Physics, A-Level Physics, and Advanced Placement (AP) Physics. These programs, widely recognized for their rigorous academic standards, prepare students for higher education in physics and related fields. The study examines key similarities and differences in curriculum structure, content coverage, assessment methods, and pedagogical approaches.

Syllabus Content Breakdown (Instructional Hours per Topic)

Topic	**IBDP SL**	**IBDP HL**	**A-Level**	**AP 1**	**AP 2**	**APC (Mech)**	**APC (E&M)**
Mechanics	22	39	40	35	-	50	-
Waves	15	17	25	20	15	-	-
Electricity & Magnetism	15	24	30	25	30	-	50
Quantum/Nuclear Physics	12	16	20	-	20	-	-
Thermal Physics	10	15	20	10	15	-	-
Fields	10	14	25	-	-	-	-
Practical/Experimental	40	60	60	25	25	20	20

The analysis reveals that while all three curricula emphasize fundamental physics principles, they diverge significantly in depth, breadth, and method of assessment. IBDP Physics integrates an interdisciplinary approach with internal assessments, experimental investigations, and an extended essay component. A-Level Physics is structured for in-depth subject specialization, with a strong emphasis on written examinations and optional modules tailored to specific physics applications. AP Physics, divided into multiple courses (AP Physics 1, AP Physics 2, and AP Physics C), allows students to choose algebra-based or calculus-based study paths, offering flexibility in preparation for university studies.

Keywords: IBDP Physics, A-Level Physics, AP Physics, pre-university physics education

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S6 O2

IMPLEMENTATION OF A NUCLEAR SAFETY AND SECURITY COURSE AT THE FACULTY OF PHYSICS, UNIVERSITY OF BUCHAREST

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[2]Horia Hulubei National Institute for R&D in Physicsand Nuclear Engineering (IFIN-HH)

The illicit trafficking of nuclear and other radioactive materials remains a major concern for global security, particularly as the use of nuclear power expands worldwide. As more countries adopt nuclear energy to meet growing demands for clean and reliable power, safeguarding nuclear materials and facilities becomes increasingly urgent. The growth of nuclear power plants (NPPs) increases the volume of nuclear materials in circulation and presents complex challenges in maintaining both safety and security across the nuclear fuel cycle.

Addressing these challenges requires a new generation of professionals equipped with the knowledge and skills to manage the technical, regulatory, and operational aspects of nuclear safety and security. The academic sector plays a critical role in meeting this need by offering specialized education and training programs.

This paper examines the implementation of an optional course on nuclear safety and security at the Faculty of Physics, University of Bucharest. The course was designed to reflect the evolving threats in the field, covering key areas such as nuclear non-proliferation, physical protection, cybersecurity, and emergency response.

Students participated in lectures delivered by experts in nuclear forensics, safety, and physical protection. Theoretical instruction was complemented by hands-on training, practical exercises, and case studies. Participants developed skills in evidence collection and analysis related to nuclear incidents and were trained to conduct cybersecurity investigations and perform Design Basis Threat (DBT) analyses.

By combining academic instruction with real-world applications, the course aimed to prepare students for the dynamic challenges of nuclear security and contribute to the development of a highly skilled workforce in this vital field.

Keywords: Nuclear Safety, Nuclear Security, Nuclear Forensics.

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LABORATORY EXPERIMENT TO STUDY THE CHANGE IN ELECTRICAL RESISTIVITY OF COPPER AT VARIABLE TEMPERATURES

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Electrical resistance is a physical quantity that shows us how much a circuit element opposes the passage of electric current through it. In certain situations, it is necessary to change the value of electrical resistance even during the operation of a certain complex circuit.

Experience shows that different circuit elements manifest themselves differently in electrical circuits. For example, if different resistors are powered at the same voltage, the intensity of the current passing through them will be different due to the microscopically different internal structure of the elements, external geometry, temperature, etc., which influence the movement of charges through the circuit, in the sense of slowing them down. The electrical resistance of a conductor depends on the electrical resistivity of the conducting material. The lower the resistivity of the material, the lower the electrical resistance, and therefore the better the conductor.

This paper presents the results of a detailed investigation of the variation of the electrical resistance of a conductor as a function of temperature and resistivity. A simple electrical circuit, including a metal resistor and a controlled heating system, was used to measure the changes in resistance at different temperatures. The experimental values were compared with the theoretical relationship. The results obtained confirm the increase in resistance with temperature in the case of metals, demonstrating the applicability of the laws of physics in the analysis of the properties of conductive materials.

This practical application and detailed analysis of the results aims to develop the student's experimental skills, critical thinking and problem solving, consolidate theoretical knowledge as well as prepare for research and career.

Keywords: electrical resistance, resistivity, temperature, investigation.

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S6 P2

THE IMPACT OF ARTIFICIAL INTELLIGENCE IN EDUCATION, RISKS AND BENEFITS

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Introduction: The impact of artificial intelligence on students' learning through a detailed approach to the adoption of AI technologies in education and the associated ethical and social challenges is a topic of interest today. The main objective of the study was to evaluate how artificial intelligence-based technologies influence students' learning processes, their efficiency in improving academic performance and the impact on traditional teaching methods. Along with this, the question of the correctness of the results delivered by artificial systems is also raised. **Material and methods**: The research was conducted based on questionnaires, applied to a sample of 64 participants, students and teaching staff from the Constanta Universities. The data's were collected and analyzed using descriptive statistical methods. **Results:** The results indicate the frequent use of AI-based tools, and the efficiency of the study through personalization of feedback. Among the identified benefits are support for research, data analysis and the creation of interactive educational materials, but there are also concerns about data confidentiality, algorithm transparency and the correctness of solutions. **Conclusions**: The study confirms the positive potential of AI in transforming education, but also the need for clear regulation of its functioning in the field and the definition of the appropriate ethical framework for the sustainable integration of AI in the educational system for a responsible implementation that balances benefits and risks.

Keywords: artificial intelligence, digital education, machine learning, intelligent feedback.

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