

# NOMATEN

Centre of Excellence in Multifunctional Materials  
for Industrial and Medical Applications

## ANNUAL REPORT 2023



European  
Funds



Republic  
of Poland



Foundation for  
Polish Science

European Union



# NOMATEN

## Centre of Excellence Partners



The National Centre for Nuclear Research  
Poland



The Atomic Energy and Alternative Energy Commission  
France



VTT Technical Research Centre  
Finland

NOMATEN Centre of Excellence Partners .....	2
Partners and Funding of the NOMATEN CoE .....	4
Project Partners .....	4
Funding .....	9
CoE NOMATEN Director’s Foreword .....	10
Future Outlook / Prospectives .....	13
CoE NOMATEN in Numbers .....	16
Scientific Activities and Development .....	18
CoE NOMATEN Scientific Activities and Development .....	18
Research Activities .....	19
New Research infrastructure .....	22
Expanding our research: Successes in grant applications .....	26
Academic Promotions .....	29
Most Notable Papers of CoE NOMATEN in 2023 .....	30
Selected CoE NOMATEN Scientific Seminars in 2023 .....	32
CoE NOMATEN Team Development .....	34
Our Team .....	35
Supporting the team .....	37
CoE NOMATEN Human Resources .....	39
CoE NOMATEN Events in 2023 .....	40
NOMATEN Innovation Days .....	41
Workshop on Advanced Materials for Nuclear and Other Applications under Extreme Conditions .....	42
Workshop on Complex Glasses .....	43
CoE NOMATEN Winter School 2023 .....	45
Industrial Events Presence and Joined Associations .....	46
Selected Main Industrial Events .....	47
1st Nuclear Power Industry Congress, September 12-13, 2023 .....	47
3rd Conference Atom for Poland .....	48
Associations Joined .....	50

# PARTNERS AND FUNDING OF THE NOMATEN COE

## Project Partners

### NATIONAL CENTRE FOR NUCLEAR RESEARCH, POLAND

The National Centre for Nuclear Research, NCBJ fundamental/applied research profile combines nuclear power-related studies with various fields of sub-atomic physics (elementary particle physics, nuclear physics, hot plasma physics etc.). The Centre is intensely involved in developing nuclear technologies and promoting practical applications of nuclear physics methods. Major market products manufactured in the NCBJ include radiopharmaceuticals (Radioisotope Centre POLATOM Department) and a range of particle accelerators for science, various industry sectors and medicine (Nuclear Equipment HITEC Department). The NCBJ Centre is an IT and R&D background infrastructure in dispensable to provide expert support for decision-makers in the project to develop the nuclear power industry in Poland in the coming years. The National Centre for Nuclear Research is the largest research Institute in Poland. We are the only Polish research institution operating a research nuclear reactor (MARIA Reactor). Currently, we are hiring over 1000 employees. Our research and scientific staff includes about 70 Professors and habilitation degree holders, as well as over 200 PhDs and Doctoral Student

## THE ATOMIC ENERGY AND ALTERNATIVE ENERGY COMMISSION, FRANCE

The Atomic Energy and Alternative Energy Commission / CEA, Commissariat à l'Énergie Atomique et aux Énergies Alternatives) is a public establishment devoted to scientific, technical and industrial research and development under the authority of the Ministries of Energy, Research, Industry and Defence. Today, The CEA is a major player in research, development and innovation in defence and security, low-carbon energies (nuclear and renewable), technological research for industry and fundamental research (sciences matter and life sciences). CEA conducts a part of its research in the French nuclear deterrent programme framework. It also provides technology to strengthen security in the face of new hazards such as terrorism and cyber attacks and to upgrade response to earthquakes and tsunamis. As a key player in energy research, the CEA mobilizes its expertise and multidisciplinary competencies to propose innovative technological solutions to address major societal challenges, such as energy transition, nuclear and renewable energy, and understanding the mechanisms of climate change. The CEA follows a research strategy encompassing the whole energy system, focusing simultaneously on means of electrical power production, both nuclear and renewable (solar), improving energy efficiency and dynamic adjustment of supply and demand through energy storage (batteries), the use of hydrogen as an energy vector, or smart power grids. Besides energy and climate change challenges, the CEA also mobilizes its expertise and multidisciplinary competencies to biotechnologies and biomedical innovations. Challenges linked to personalized medicine and technologies for the medicine of the future are priorities, and dedicated research are conducted in the field of in vivo molecular imaging probes, diagnostic tools and molecules for therapeutic or theranostic uses. Methodologies devoted to isotopic labelling remain a CEA specificity, both serving drug development and radiopharmaceutical development.

into sustainable growth for businesses and society, bringing together people, business, science and technology to solve the biggest challenges of our time. VTT represents a multidisciplinary technological know-how and has strong expertise in materials research and nuclear energy research to support the energy transition and pathway towards a sustainable economy.

The VTT team has indicated its willingness to provide nuclear safety training. Therefore building an offer for companies and enterprises in Poland

**'CoE NOMATEN operates as a self-driven Research Unit, housing independent laboratories and resources within the framework of NCBJ'**

”

**'We will accompany Nomaten in consulting and advising under the new nuclear programme'**

”

Magnus Simons, VTT Technical Research Centre of Finland  
Leader of Workpackage 7 Innovation-based sustainability

## VTT TECHNICAL RESEARCH CENTRE OF FINLAND

VTT Technical Research Centre of Finland is the leading research and technology company in the Nordic countries. VTT use research and knowledge to provide expert services for our domestic and international customers and partners both from the private and public sectors. We use 4,000,000 hours of brainpower a year to develop new technological solutions. VTT brings together over 2,000 experts. VTT Group's turnover is approximately 270 million EUR yearly. VTT's mission is to help customers and society to grow and renew through applied research. We have 75 years of experience supporting our clients' growth with top-level research and science-based results. VTT develops new smart technologies, profitable solutions and innovation services, and cooperate with its customers to produce technology for business and build success and well-being for the benefit of society. A brighter future is created through science-based innovations. With over 2200 employees, VTT advances the utilisation and commercialisation of research and technology in commerce and society and provides expert services for domestic and international customers and partners, both private and public sectors. The turnover of VTT Group is approximately EUR 260 million yearly. VTT's mission is to help customers and society to grow and renew through applied research. With over 80 years of experience supporting clients' growth with top-level research and science-based results, VTT develops new smart technologies, profitable solutions and innovation services. Through scientific and technological means, VTT turns large global challenges





## FUNDING

The Centre of Excellence NOMATEN has received funding from the European Regional Development Fund via the Foundation for Polish Science International Research Agenda PLUS programme grant No MAB PLUS/2018/8 and from the European Union Horizon 2020 research and innovation programme under grant agreement No 857470. Additional NOMATEN activities are funded by the ORIENT-NM (Organization of the European Research Community on Nuclear Materials) grant (Horizon 2020 Framework Programme, grant agreement No. 899997) and the GOSPOSTRATEG-HTR project financed by the National Centre for Research and Development.

In 2023, individual scientists from NOMATEN have received several research grants from various Polish and international funding agencies, such as the National Science Centre Poland, European Commission Marie Skłodowska-Curie Actions and Regional Agencies (Mazovian Marshall).

***In 2023 CoE NOMATEN  
Submitted Projects  
for the value of ca.  
30 M EUR***

# COE NOMATEN DIRECTOR'S FOREWORD

*'The NOMATEN Teaming project's main objective is to support the growth of the NOMATEN CoE dedicated to Multifunctional Materials for Industrial and Medical Applications, a tool to train a new generation of researchers and set up competitive research and innovation programs in the European environment'*



The last year has been very busy for all CoE NOMATEN members: we have transitioned from the start-up phase to the stable growth period. Developments in the Research Agenda were coupled with increased successes in attracting grant-based funding for our researchers, broadened international and national cooperation, welcoming new team members and procuring and implementing significant elements of our research infrastructure.

## RESEARCH AREA:

**Complex alloys:** The NOMATEN team has produced many results and papers on these systems, including in the amorphous/glassy state. A particular interest is still the question of how and why the mechanical properties of HEAs (High Entropy Alloys and similar complex systems such as Oxide Dispersion-Strengthened steels and alloys and variants) depend on their constitution. Experimental research in this area has become very strong with collaborations. We are part of a consortium (INNUMAT) that started during the reporting period.

## RESEARCH ACTIVITIES:

Nanoindentation is a key testing method for the properties of metals and alloys, particularly concerning the effects of irradiation. This is also our strength in the INNUMAT consortium. We combine multiscale modelling with experiments and novel types of materials.

## RESEARCH AND INNOVATION ACTIVITIES:

The Materials' Characterization group is now at its disposal, thus the whole CoE, a Scanning Electron Microscopy environment and in the summer of 2023 a very modern JEOL Transmission Electron Microscope was taken into use. The first papers where the latter has been exploited have already been published. These will also allow for joint research with commercial companies. There is a development plan for this ecosystem, approved by the International Scientific Committee in July, 2023.

## RESEARCH AND INNOVATION ACTIVITIES:

As a novel opening, we have invested much effort in material informatics. In 2022, a conference was organized in early June at NCBJ for every first in Poland Materials Informatics conference with about 60 participants, most of them on-site. This shows that we have quickly taken a leading international role here, and we are now a leading partner in the Euratom October 2023 call consortium Connect NM, responsible for one of the Research Lines / Work Packages. This kind of work fully aligns with the EC-promoted trends for FAIR and open data.

## RESEARCH AND INNOVATION ACTIVITIES:

The radiopharmaceutical group has reached a steady-state operation and is involved in joint research with CEA, POLATOM and VTT. Research is already conducted in the development of therapeutic radiopharmaceuticals based on alpha-particle-emitting radionuclides (eg Bi-213, Ac-225 and Th-227) and in the development of small molecules radiolabelled with I-123/124 for SPECT/PET applications. Another direction is the use of nano micelles to encapsulate gold nanoparticles.

## INNOVATION AND INDUSTRIAL COOPERATION ACTIVITIES:

The innovation dimension of the SRIA is being cultivated in terms of nuclear and non-nuclear materials science. The ILG has established contacts with more than 30 companies in Poland and elsewhere, and we now have the first two actual research contracts (notably with Mercedes-Benz Poland). NOMATEN, as part of NCBJ, and thanks to close links with CEA and VTT, is well positioned for the Polish nuclear energy programme. This has been recently confirmed by solid participation at the April Finnish-Polish summit for nuclear energy (initiated

by VTT but then „upgraded” as a governmental initiative) and with a drive to establish, in the near future, joint funding schemes for international collaboration.

#### INNOVATION AND INDUSTRIAL COOPERATION ACTIVITIES:

On May 24-25, we organized the first NOMATEN Innovation Days event - an industry-oriented event focusing on companies' expectations, needs and experiences in R&D projects and scientific services. The first day was dedicated to the nuclear industry - materials research, research services, requirements and expectations for companies entering the project. The second day was dedicated to general engineering issues (e.g., materials research and radiography in the chemical, energy, automotive, and metallurgical industries etc.). The event was attended by more than 80 representatives of industry and governmental organizations, as well as institutions responsible for funding R&D&I programs in Poland.

#### INFRASTRUCTURE:

The success in implementing new research equipment purchased in 2023 into the research processes has resulted in a relatively complete materials research environment. Strategic directions of extensive infrastructure have been defined and discussed with the ISC. In all cases, the equipment purchases are combined with personnel training and hiring specialists. We next await the completion of the CERAD cyclotron facility and the installation of neutron diffraction equipment at the MARIA Reactor.



## Future Outlook / Prospectives

### Our Pro Industrial Strategy!

The CoE NOMATEN's continuously improved marketing strategy for various industrial sectors (nuclear and conventional energy, automotive, toolmaking, metalworking), includes several strategic objectives for the development of the CoE's technical consulting potential with a primary focus on expert, technical and research support for the companies. Centre achieves them by targeting research methods and capabilities not yet realised by companies at the stage of product design and manufacture (technology optimisation), product implementation (quality control), and support in determining the causes of damage or low durability of products (material expertise, component improvement technologies). With a broad research experience and infrastructure capabilities, it becomes crucial for CoE NOMATEN to promote a strong focus on industrial sectors through B2B and B2S meetings with companies at trade fairs, industrial symposia, conferences or visits directly to companies.

Equally important is CoE NOMATEN's ongoing analysis of companies operating on the national and international market and determining to what extent they are suited to operate, for example, in the power sector supply chain (incl. nuclear) or a specific industrial sector and to what extent support from the Centre is possible. It is known that changes in companies operating conditions associated with economic changes in Europe (post-pandemic period - disruption of supply chains, conflict in Ukraine), as well as the transformation of many industries in Poland, associated with the departure from coal and fossil fuels combustion, and the implementation of the Polish Nuclear Energy Programme, should stimulate companies to evolve. The above conditions require the many branches to make changes and technological adaptations typical of the technology and product user. This gives rise to the need for significant investment in research and development, thus necessitating cooperation with highly qualified research units and centres of excellence. Strictly at this point, opportunities to collaborate with CoE NOMATEN in conducting research, acquiring R&D projects and forming new technology consortia. CoE NOMATEN is also aware that the transformation of the energy market in Poland and the transition from conventional to nuclear energy will set new standards and requirements in the R&D sphere, which CoE NOMATEN will be able to meet and implement by supporting national and international companies in R&D activities.

Therefore, currently, CoE NOMATEN has several research capacities on offer, which are subject to continuous development and changes related to the adaptation of the research conducted to the latest standards and procedures for implementing certified research. In the 2023/2024 perspective, a detailed industry offer will be prepared, and changes will be made to the CoE website so that industrial units can analyse CoE research opportunities for potential collaboration and research implementation. The ILG CoE NOMATEN team is also constantly working on introducing a CRM (Customer Relationship Management) system linked to a database of companies with which the CoE has established contact during the project. In addition, ongoing changes in CoE NOMATEN's research capabilities mean that the research offering needs to be expanded to include newer and more advanced research (such as materials characterisation using TEM/STEM). In addition, the promotion of CoE NOMATEN to industrial actors will also be carried out by organising meetings with companies both at CoE NOMATEN premises and directly at companies, which is an excellent way to obtain long-term collaborations, as evidenced by the cases of BIMOTECH or ALTRAD Babcock mentioned in the report (Section 4.5. and 6.6. of the Deliverable).

NOMATEN develops partnerships with industry and research organizations to perform and deploy go-to-market solutions in innovative materials and radiopharmaceuticals. NOMATEN’s scientists are supported by a team of experts with an extensive experience in marketing, communication, human resources and international cooperation. The project’s marketing strategy focuses on collaboration with industry, but the NOMATEN Centre of Excellence is working to improve industrial orientation. The other significant areas of the strategy are:

- Organization of Innovation and Industry Open Days, Public Open Days.
- Organization of business meetings at the Companies Site.
- It was recognised that flyers with NOMATEN testing capabilities for different industry sectors will be required.
- Targeted offers for companies.
- B2B meetings with companies.
- Dedicated R&I events.;

*‘In the current phase of the project, we are strongly focused on enhancing CoE NOMATEN international visibility and fostering partnerships within the Polish business environment’*



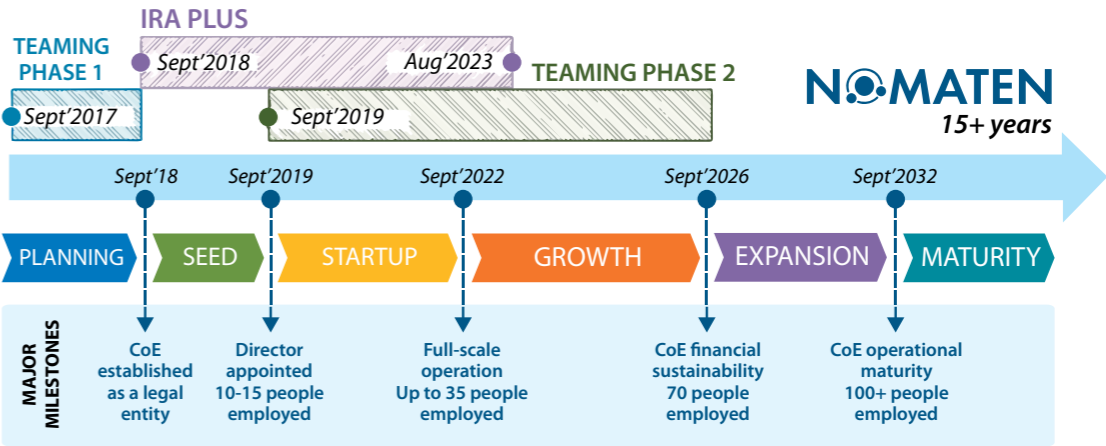
Jaroslaw .Jasiński, CoE NOMATEN Industry Liason Group Member

We offer research services to industrial entities across various economic sectors, including the energy sector. Our laboratory is accredited by the Polish Centre for Accreditation, ensuring independent and reliable research and maintaining measurement consistency in accordance with our internal procedures, Quality Policy, and the requirements of the PN-EN ISO/IEC 17025:2018–02 standard. Additionally, we collaborate scientifically with leading national and international scientific institutions and research institutes, conducting research and development in manufacturing and studying advanced materials.

The laboratory provides research services to commercial entities and scientific partners. Our established management system offers our clients independent, impartial, and reliable testing.



15+ YEARS PLANNING HORIZON



CoE NOMATEN Project overall progress and development phase plan

# COE NOMATEN IN NUMBERS



6000 +	Users of the website
40 +	Press releases
1000 +	Followers on LinkedIn
50 +	Users on LinkedIn
30 +	Online and hybrid seminars
20 +	Industry events participation
9 +	Promo materials pack set
80 +	Papers published
85 +	S2B Meetings with Companies
5 +	Associations joined
5 +	Events organized 2 with over 100 + Attendies
10 +	Projects granted
5 +	R&D Commisions from the industry
10 +	International Scientists joined

# SCIENTIFIC ACTIVITIES AND DEVELOPMENT

## COE NOMATEN SCIENTIFIC ACTIVITIES AND DEVELOPMENT

### Research Activities

During the past year, CoE NOMATEN MAB has consolidated itself in terms of structure and research capabilities. Further essential developments are ongoing based on this achievement. These include the exploitation of modern materials science laboratory equipment. The key concept in this regard is the research cycle of sample preparation, characterization, and material property testing. The main new resources are a Scanning Electron Microscope with additional tools for sample preparation and metallurgical studies while arc-melting for sample preparation and a Transmission Electron Microscope taken into use in the summer of 2023. At the unit, we combine experimental approaches to materials modelling. Key capabilities in this direction are available and used for joint research with experimental groups. During the reporting period, the CoE had four fully working groups in materials science (RGs) and one more in radiopharmaceuticals, which has experienced rapid growth. The build-up of the research facilities for this group has been going on, and preparations for the CERAD facility exploitation. We also have an activity in corrosion or electrochemical research due to the MCSA grant of Alexandra Baron-Wiechec.

The development of the research in these groups has followed many joint themes. First, NOMATEN should be able to research materials (and radiopharmaceuticals) across the so-called Technology Readiness Levels (TRL) from applied/high-level TRL to basic, low TRL levels. Excellent basic research will be a pillar for future industrial applications and problem-solving in extreme conditions. The second is the tight interaction and collaboration between modelling and experiment. A key modern direction is material informatics. Data is exploited using machine learning and artificial intelligence. One key concept is material informatics-aided material design. The idea is to aid the experimenter by suggesting material compositions such that they would produce key properties. We have several projects on alloy and metallic glass going on. The CoE also supports technical specialists who aid with data management and ML software development.



NOMATEN also develops its research in materials for nuclear applications. This field is inherently international, as manifested by European efforts such as Orient-NM and M4F, and the future role of the unit is enormously helped with the aid of the Teaming partners VTT and CEA. Areas where our novel and developing expertise should leave a mark and work is ongoing are advanced materials, such as High-Entropy Alloys for nuclear applications and amorphous coatings. This is now highlighted by our successful participation in the INNUMAT consortium, a 4-year Euratom effort which started in October 2022, where we participate in two work packages with our key capabilities (material testing and modelling). We are heavily involved in preparing the Connect NM consortium and proposal, where Michal Pecelerowicz is one of the few Work Package / Research Line leaders (data management and material informatics).

Highly important challenges in extreme environments generally require new solutions. We developed research activities in complex metal glasses and High Entropy Alloys. As a materials design problem, a typical important example is finding compositions that avoid some undesired elements and possess excellent mechanical properties. The yielding of glasses and alloys has been an intensive research activity at the unit. We are applying advanced modelling methods and machine learning approaches to understand the physics of strength and its dependence on the material composition. The work in the future will be extended to a hand-shake with experiments, as such glasses are expected to be outstanding coating candidates.

An example of the synergy from modelling to materials theory to materials informatics to high-quality experiments is given by Nanoindentation. NOMATEN has access to the NCBJ NI equipment, which allows testing metal alloys, glasses, and coatings at room and elevated temperatures. We are now at the point in which we can, both by experiment and by numerical modelling, study novel materials. Several projects and manuscripts were carried out, and the results were already published. The incoming Polonez Bis fellow Timofii Khvan shall work in this area, emphasising the irradiation resistance of advanced steels.

The two experimental groups work together (Structure and Function; Materials Characterization) and with the modelling effort. New laboratory capabilities have been acquired (metallurgy lab, Scanning Electron Microscope with its advanced environment, Transmission Electron Microscope, and corrosion lab to support Prof. Baron-Wiechec MCSA fellowship, which started in September 2021). The experimental work has already led to essential steps such as novel collaborations and funding (Polonez Bis fellowship of Drs. Huo and Khan) and new science on HEAs, advanced steels and coatings.

Radiopharmaceutical research collaborates closely with CEA and VTT from abroad and with Polatom locally. The main focus of the research was on two topics: novel groups for radiohalogenation for biomolecules and synthesis and characterization of nano micelles for carriers (of radionuclides and other agents) for cancer therapy. The group successfully started a co-tutelle project with CEA, and the PhD student is now being shared. The RG was and is also preparing for the exploitation of the CERAD facility at NCBJ and building its research environment at NOMATEN. The RG was a leading partner in an EC EIC Pathfinder proposal, which narrowly missed being funded.

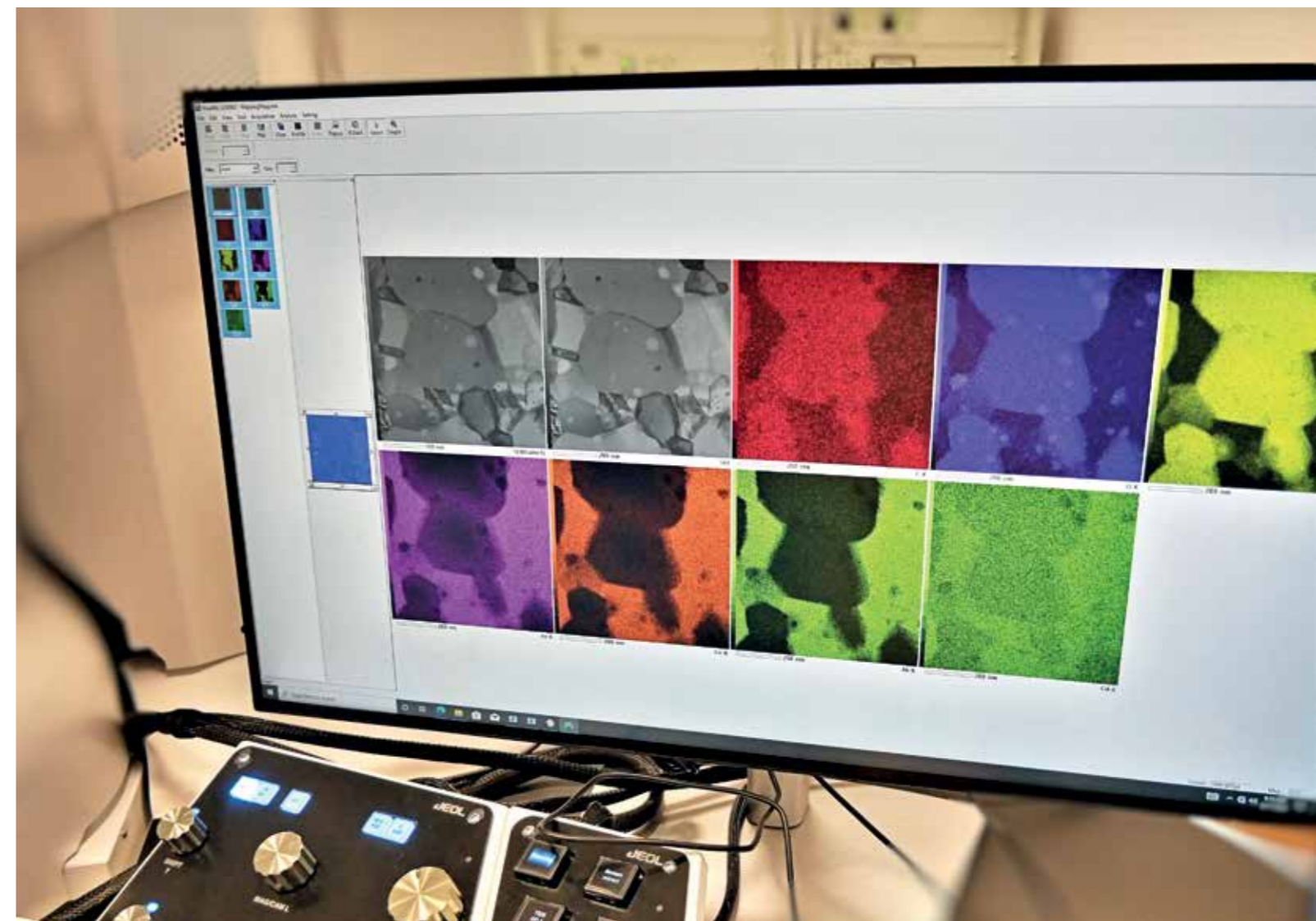
The CoE NOMATEN now has six individual grants: the MCSA supporting Prof. Baron-Wiechec as a MCSA fellow (in corrosion), the INNUMAT consortium, the Polonez Bis of Dr. Wenyi Huo (synthesis of novel HEA materials, with a PhD student funded in addition) and Timofii Khan (to start in January 2024), plus two NCN Sonatinas and one Preludium. We have applied for various grants either by individual researchers or as a CoE partner in Poland and in various EC calls: a considerable number of proposals is under evaluation, including big consortia projects. In addition to setting up the Industry Liaison Group and other mechanisms for commercial cooperation, we have had our first real industrial projects (Mercedes-Benz Poland, BIMOTECH, Bureau

Veritas, Tomex Brakes, BlueScope Steel). Our nuclear energy materials expertise makes us look forward to the possibilities arising from the future developments of the Polish nuclear energy sector. There, we are helped by the nuclear energy competencies of our Teaming partners.

CoE NOMATEN researchers have started participating in scientific meetings in Poland and elsewhere.

Research exchanges to collaborate and interact with CEA and VTT started to pick up. We plan to organize several events in 2023 and 2024 (Glass workshop, Radiopharmaceuticals International conference in June 2024, Innovation/Industry Days 2024). This kind of scientific networking and brand development is also carried out by the bi-weekly NOMATEN seminars, which have been run in a remote mode, but a shift to a hybrid mode in which speakers are invited to NOMATEN but external audience is possible by modern tools is going on.

CoE NOMATEN, as a Center of Excellence, should also actively promote its staff in their careers from the get-go. We encouraged team members to participate in scientific training and events, mentored them, and encouraged them to participate in calls to get grants. Training for working in an international environment has been on the agenda during the reporting period. In the future, we intend to continue to organize professional events to develop our staff's understanding of important issues such as grant or proposal writing, Intellectual Property Rights issues, and the exploitation of IPR. Last but not least, our senior staff is actively pursuing promotions in the national academic system (Javier Dominguez obtained habilitation in the period, Malgorzata Frelek-Kozak and Anna Kosinska received their Ph.D. title), and several more are ongoing.



## New Research infrastructure

Several research infrastructure pieces were purchased and installed in the past 18 months. Different projects currently realized at NCBJ, e.g., MAB+, Teaming (on a limited scale as it is devoted instead to infrastructure maintenance), SPUB, and HTGR, contributed to the renovation of the NCBJ capabilities regarding material characterization. Two of the most significant endeavours are (i) setting up advanced microscopy laboratories, which include state-of-the-art SEM & TEM systems (both microscopes are equipped with high-end sample preparation infrastructure), and (ii) the Material Research Laboratory Building renovation, together with the purchase of smaller equipment. This renovation included laboratory space, basements, and offices located on the first floor of the building. The renovation was terminated in September 2023 and lasted for two years.

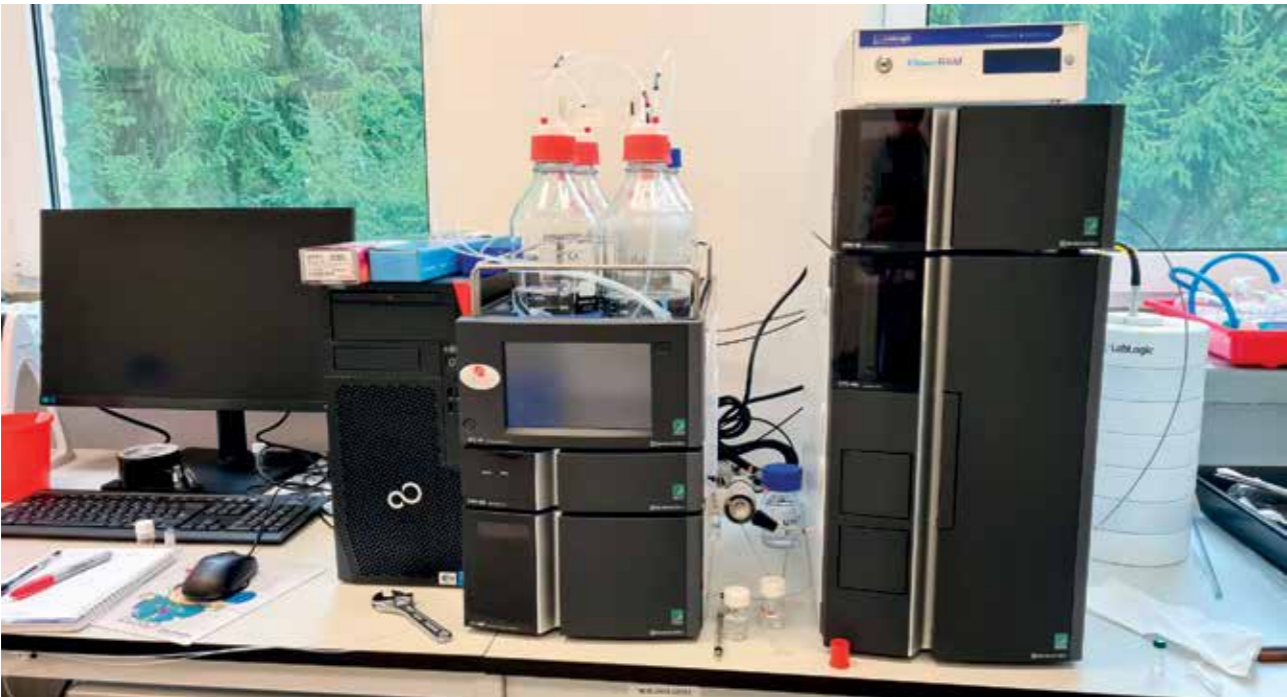
By combining funding from different sources, NCBJ is expected to be able to provide unique material characterization capabilities, which will result in building new scientific consortia and industrial projects, especially those related to the nuclear power program.

### Materials research: New TEM laboratory

As the main news, the High-Resolution Field Emission Transmission Electron Microscope System **JEOL JEM-F200** was installed in July 2023. This instrument completes our microscopy and characterisation facilities and the experimental team composed a development strategy submitted to the ISC for a review. We have already had the first scientific publications coming out of the TEM/SEM environment, that is to say, from our increased capabilities. This significant purchase was complemented by multiple „small” (i.e. in the cost range of 100k€) devices. In the domain of materials studies, these purchases were focused mainly on the capacity to create in-house advanced materials: High Entropy Alloys, samples suitable for mechanical and irradiation studies, coatings, etc.



Transmission Electron Microscope System JEOL JEM-F200



HPLC with UV-VIS and radiometric detectors in the radiopharmaceutical

### From small to very large: CERAD Facility at POLATOM

The medium size equipment located at NOMATEN is only a part of the research infrastructure available for radiotherapy research. We have access to modern hot cells and radioisotope production capacities through a partnership with POLATOM and the MARIA reactor at NCBJ. These possibilities will soon be expanded through the start of operations of the CERAD facility, equipped with a cyclotron capable of accelerating particles up to 30 MeV energy. The objective of the CERAD project is to develop a modern infrastructure dedicated to research on new diagnostic/therapy radiopharmaceuticals based on ligands biologically active on the cell/molecular level. Radioactive isotopes combined with disease molecular markers may help to diagnose some serious diseases and apply suitable treatment sooner than before. The project meets the challenges of developing effective cancer diagnostics/therapy methods in line with worldwide socio-demographic trends.

The CERAD facility installed in NCBJ Centre

### Radiopharmaceutical Laboratory

In 2023, several small and medium-sized equipment devoted to experimental studies by Radiopharmaceuticals Group members were purchased and installed at NCBJ. Purchased small research infrastructure included magnetic stirrers with a heating function, rotavapor with vacuum pump, water demineralizer, UV lamp, laboratory drying oven, automatic probes shaker, ultrasonic bath, and analytical weight balance. The medium-sized devices included HPLC systems with UV-VIS and radiometric detectors, an ionization chamber (dose calibrator) and a phosphor imaging system for autoradiography. The mentioned purchased infrastructure is basic and essential to perform chemical and radiochemical studies on development of radiopharmaceuticals, mainly to check if planned reaction is ongoing and to estimate its yield, purify the final product, and determine its purity. These medium-sized devices include an analytical HPLC system, a preparative HPLC system, and a scanner for indirect digital autoradiography.



## Expanding our research: Successes in grant applications

**Dr Wenyi Huo** is heading a grant Development of nano-twinned high-entropy alloys with superior mechanical properties and enhanced irradiation resistance from 01.11.2022 to 31.10.2025. The scientific goal of the proposed research project is to comprehensively understand the effect of nano-twins in HEAs on mechanical properties and irradiation resistance. Some of the hypotheses include that nano-twinned HEAs can show superior mechanical properties and enhanced irradiation resistance. They also include the stable nanostructure following irradiation and no significant increase of dislocation microstructures under mechanical load following irradiation.

CoE NOMATEN is the host institution for two Polonez Bis grants:



**Dr Timofii Khvan** will head the grant Mechanical and structural properties of RAFM steels - impact of radiation damage, 01/2024 – 12/2025. Materials chosen for constructing structural components in nuclear reactors require careful selection and characterization, as their operational conditions presume the constant influence of harmful neutron irradiation, which undesirably degrades their mechanical properties and eventually may lead to the failure of the component. Therefore, we need to ensure that the margin of safety of the material is enough to sustain a certain amount of neutron damage. However, neutron irradiation for research purposes is a costly, lengthy and complicated process, so the possibility of imitating the damage of neutrons by other types of irradiation is of high interest. In this research, we aim to substitute complicated neutron irradiation with relatively cheap, fast, and safe ion irradiation, analyze its impact on mechanical properties, deeply investigate the microstructural changes it does, and compare it with the existing data done with neutrons. We target to establish an experimentally-computational procedure for effectively characterizing the consequences of ion irradiation as a surrogate for neutron irradiation. This will allow us to accelerate the delivery of new research data on structural materials for nuclear applications.



**MSc. Eng. Edyta Wyszowska** is the Principal Investigator of the National Science Centre (NCN) grant PRELUDIUM 21, Impact of radiation damage on the structural and mechanical properties of fcc NiFe single crystal alloys. Materials planned to be used as components of the future fission and fusion reactors should be carefully selected due to the harsh operational conditions of these devices. Despite broad studies and advancements in material characterization, multiple irradiation phenomena, such as swelling, embrittlement, and defect aggregation zones, require careful understanding. Developing new high-performance materials that can withstand such hostile

conditions is critical for advanced fission and fusion reactor systems. In addition, the demanding environment of future nuclear power systems will require improved irradiation resistance and high-temperature mechanical performance from the component materials. An accurate understanding of the mechanical properties at elevated temperatures is vital for all these applications to ensure safe operation. Due to this reason, the development of new materials with superior mechanical properties (especially at high temperatures) and radiation resistance is a significant concern. This forms the primary motivation of the proposed work, where the evolution of functional properties of newly developed fcc NiFe single crystal alloys will be studied under extreme conditions (high temperature and ion irradiation). The project will answer major research questions related to such materials: 1) What are the types of defects created during irradiation?; 2) What are the sizes, density, and distribution of the defects in fcc NiFe single crystals?; 3) How does the defect evolution/migration occur with varying irradiation fluences and concentration of Fe; 4) How do various defect microstructures impact the mechanical properties?; 5) What is the impact of varying Fe concentration and irradiation fluences on mechanical properties of Ni and NiFe single crystals?; 6) What is the mechanical response of pristine and irradiated NiFe single crystals at elevated temperatures?



**Dr Agata Sotniczuk** is a laureate of the SONATINA 7 grant from NCN, titled Novel metastable titanium beta-phase alloys based on the Ti-Mo system for applications in the modular total hip replacements. The research addresses problems related to degenerative diseases of hip and knee joints, which have been ranked at the 11th place of the most frequent health disabilities observed worldwide. In case of patients who experience chronic pain and severe limitation of their mobility, Total Hip Arthroplasty (THA) gives a chance to improve the quality of their life significantly. However, currently used alloys are claimed to be potentially toxic to human health. This projects offers the solution to this problem by exploiting a new group of metastable beta-phase titanium alloys created based on Ti-Mo system, that offers a unique set of features derived from the activation of additional deformation mechanisms. Alloys will demonstrate the desirable combination of high mechanical strength and ductility. The general objective of this project is to fabricate a new alloys based on Ti-Mo system, which are capable of the complex conditions as can be found at the metallic interfaces of modular total hip replacements.





**Dr Magdalena Gawęda** will lead the NCB SONATINA 7 project Amorphous silicon oxycarbide-based protective coatings on steel for cladding materials in nuclear reactors. The scientific project aims to develop amorphous protective coatings based on silicon oxycarbide (SiOC) to enhance the radiation tolerance and high-temperature stability of structural elements within nuclear reactors. The interest in this material arises from its favourable mechanical properties, strong adhesion to metallic substrates, chemical and thermal stability, and radiation tolerance with resistance to helium bubble formation, all of which result from its unique structure. SiOC is a two-

phase material consisting of an amorphous silica-based matrix with oxygen ions partially substituted by carbon and a graphite-like disordered free carbon phase. The exact composition, particularly carbon content and ionic modifications, must be precisely controlled to ensure desirable properties.

In this project, she will prepare materials using the so-called polymer-derived ceramics method. This will involve the pyrolysis of self-synthesized ladder-like silsesquioxanes with designed carbon and iron content (as an additional matrix modifier) deposited on AISI 316L austenitic stainless steel. The work will cover comprehensive structural, microstructural, and mechanical analyses of SiOC coatings with varying carbon content and iron ionic modifications. A thorough examination will be conducted both before and after irradiation with light and heavy ions, as well as in-situ at elevated temperatures. The results will yield fundamental research of high scientific significance that is directly applicable to the capabilities of the alloy/SiOC composite in resisting the harsh environment of nuclear reactors.



## Academic Promotions



### Habilitation

**Dr Javier Dominguez-Guterres** was awarded the habilitation degree in April 2023 based on his research on Atomistic-based computational modelling of irradiation damage in crystalline and amorphous materials at extreme operating environments. Dr Dominguez-Guterres plans to continue and develop his research at NOMATEN by answering a fundamental scientific question: What are the mechanisms responsible for hardening and plastic deformation of materials with superior properties such as outstanding yield stress increase, hardening, and stability at elevated temperatures and irradiation dose?

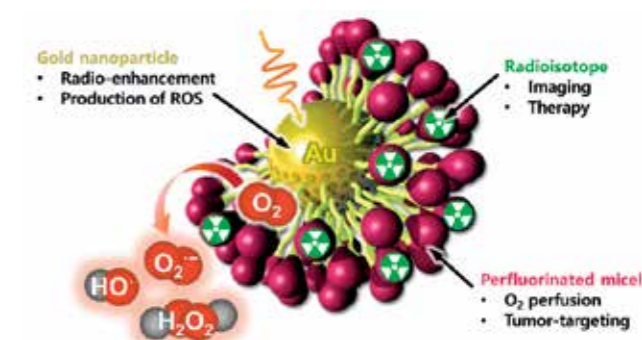
### Doctoral degrees

Two members of our NOMATEN team, **Dr. Anna Kosińska** from the Materials Characterization Group and **Dr. Małgorzata Frelek-Kozak** from the Functional Properties Group, who both successfully defended their Ph. D.s last year, received their well-deserved diplomas during an official ceremony at the Warsaw University of Technology on October 4th, 2023.



### International competitive doctoral programmes

**Mathilde Ponchelle** is the first „true” co-tutelle PhD candidate, winner of the „ADI (Action doctorale-Internationale) UPSaclay » 2022. The doctorate is conducted in collaboration between CEA / SCBM (Nanosciences research group) – Eric Doris / Université Paris-Saclay (Saclay, France) and NOMATEN CoE / NCBJ (Radiopharmaceuticals Group) - Marek Pruszyński / ICHTJ (Warsaw, Poland). The topic is especially important for cancer research, and involves design and synthesis of theranostic micellar nano-carriers for imaging and targeted radiosensitization. The objective of this cotutelle PhD thesis project is to design nanometric platforms based on gold nanoparticles encapsulated in fluorinated micelles. Micelles will be designed to become biocompatible and can passively reach the tumour area thanks to local leaky vasculature (EPR effect, Enhanced Permeability and Retention). The contribution of gold is essential as a sensitizer for radiotherapy. In fact, gold can potentiate radiotherapeutic treatments by producing altering species upon irradiation. We thus anticipate better efficacy of radiotherapy.



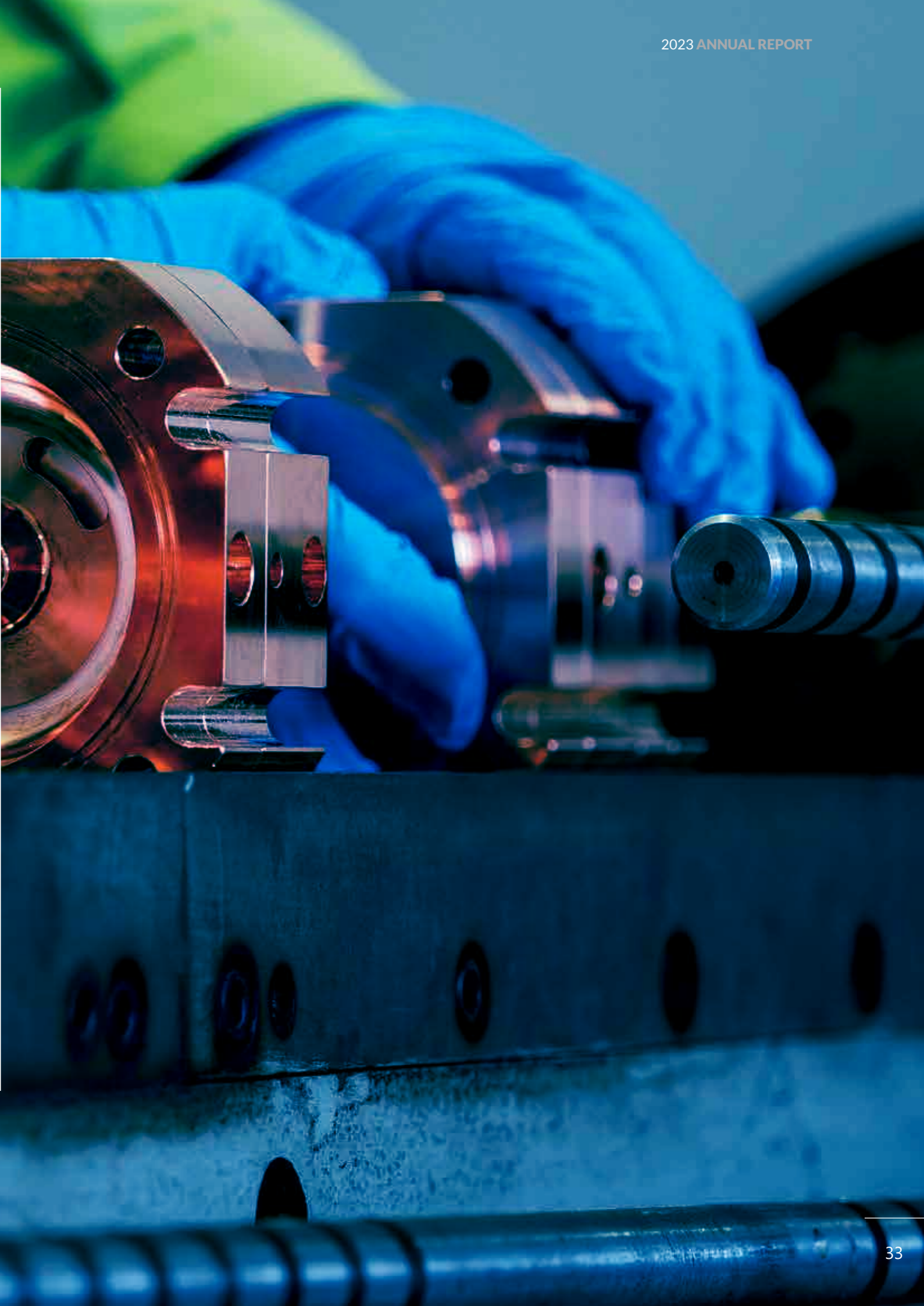
## Most Notable Papers of CoE NOMATEN in 2023

M.Frelek-Kozak, Ł.Kurpaska, K.Mulewska, M.Zieliński, R.Diduszko, A.Kosińska, D.Kalita, W.Chromiński, M.Turek, K.Kaszycza, A.Zaborowska, J.Jagielski Mechanical behavior of ion-irradiated ODS RAF steels strengthened with different types of refractory oxide, Applied Surface Science, Volume 610, 1 February 2023, 155465
Rafał Psiuk, Tomasz Mościcki, Justyna Chrzanowska-Giżyńska, Łukasz Kurpaska, Joanna Radziejewska, Piotr Denis, Dariusz Garbiec, Marcin Chmielewski Mechanical and Thermal Properties of W-Ta-B Coatings Deposited by High-Power Impulse Magnetron Sputtering (HiPIMS), Materials 2023, 16(2), 664
Magdalena Gawęda, Piotr Jeleń, Maciej Bik, Magdalena Szumera, Zbigniew Olejniczak, Maciej Sitarz Spectroscopic studies on phosphate-modified silicon oxycarbide-based amorphous materials, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy
M. Nowak, K. Mulewska, A. Azarov, Ł. Kurpaska, A. Ustrzycka, A peridynamic elasto-plastic damage model for ion-irradiated materials, International Journal of Mechanical Sciences, Volume 237, 1 January 2023, 107806
F. Javier Domínguez-Gutiérrez, Amil Aligayev, Wenyi Huo, Muralidhar Chourashiya, Qinqin Xu, Stefanos Papanikolaou, CH <sub>4</sub> , and CO <sub>2</sub> with $\alpha$ -Alumina Surfaces: Density-Functional Tight-Binding Calculations
K. Suchorab, M. Gawęda, L. Kurpaska, Comparison of Raman imaging assessment methods in phase determination and stress analysis of zirconium oxide layer, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy Volume 295, 5 July 2023, 122625
K. Mulewska, F. Rovaris, F.J. Dominguez-Gutierrez, W.Y. Huo, D. Kalita, I. Jozwik, S. Papanikolaou, M.J. Alava, L. Kurpaska, J. Jagielski, Self-ion irradiation effects on nanoindentation-induced plasticity of crystalline iron: A joint experimental and computational study, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Volume 539, June 2023, Pages 55-61
Amir H. Naghdi, Kamran Karimi, Axel E. Poisvert, Amin Esfandiarpour, Rene Alvarez, Pawel Sobkowicz, Mikko Alava, and Stefanos Papanikolaou, Dislocation plasticity in equiatomic NiCoCr alloys: Effect of short-range order, Phys. Rev. B 107, 094109
K. Frydrych, F.J. Dominguez-Gutierrez, M.J. Alava, S. Papanikolaou, Multiscale nanoindentation modelling of concentrated solid solutions: A continuum plasticity model, Mechanics of Materials Volume 181, June 2023, 104644
Magdalena Gawęda, Magdalena Wilczopolska, Kinga Suchorab, Małgorzata Frelek-Kozak, Łukasz Kurpaska, Jacek Jagielski, Surface and in-depth structural changes in nuclear graphite irradiated with noble gases described with Raman imaging, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Volume 538, May 2023, Pages 103-109
A. Zaborowska, Ł. Kurpaska, E. Wyszowska, A. Azarov, M. Turek, A. Kosińska, M. Frelek-Kozak, J. Jagielski, High versus low energy ion irradiation impact on functional properties of PLD-grown alumina coatings, Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms Volume 540, Pages 24-29
F. J. Domínguez-Gutiérrez, P. Grigorev, A. Naghdi, J. Byggmästar, G. Y. Wei, T. D. Swinburne, S. Papanikolaou, and M. J. Alava, Nanoindentation of tungsten: From interatomic potentials to dislocation plasticity mechanisms, Phys. Rev. Materials 7, 043603
Karol Frydrych, Modelling Irradiation Effects in Metallic Materials Using the Crystal Plasticity Theory—A Review, Crystals 2023, 13(5), 771
Anniina Kinnunen, Ivan V. Lomakin, Tero Mäkinen, Kim Widell, Juha Koivisto, and Mikko J. Alava, Striation lines in intermittent fatigue crack growth in an Al alloy, Phys. Rev. Materials 7, 053602
Kamran Karimi, Henri Salmenjoki, Katarzyna Mulewska, Łukasz Kurpaska, Anna Kosińska, Mikko J. Alava, Stefanos Papanikolaou, Prediction of steel nano hardness by using graph neural networks on surface polycrystallinity maps, Scripta Materialia Volume 234, 115559

Wenqi Huo, Shiqi Wang, F. Javier Dominguez-Gutierrez, Kai Ren, Łukasz Kurpaska, Feng Fang, Stefanos Papanikolaou, Hyoungh Seop Kim, and Jianqing Jiang, High-entropy materials for electrocatalytic applications: a review of first principles modelling and simulations, MATER. RES. LETT. 2023, VOL. 11, NO. 9, 713–732
Kamran Karimi, Mikko J. Alava, and Stefanos Papanikolaou, Yielding in multicomponent metallic glasses: Universal signatures of elastic modulus heterogeneities, PHYSICAL REVIEW MATERIALS 7, 063601 (2023)
Shiqi Wang, Wenqi Huo, Hanchen Feng, Zonghan Xie, Jian Ku Shang, Eric V. Formo, Pedro H. C. Camargo, Feng Fang, Jianqing Jiang, Enhancing Oxygen Evolution Reaction Performance in Prussian Blue Analogues: Triple-Play of Metal Exsolution, Hollow Interiors, And Anionic Regulation, Advanced Materials Volume35, Issue45 November 9, 2023 2304494
A. Sotniczuk, J.L. Gilbert, Y. Liu, M. Matczuk, W. Chromiński, D. Kalita, M. Pisarek, H. Garbacz, Corrosion resistance of $\beta$ -phase titanium alloys under simulated inflammatory conditions: Exploring the relevance of biocompatible alloying elements, Corrosion Science, Volume 220, 1 August 2023, 111271
J. Jasiński, T. Stasiak, W. Chmurzyński, Ł. Kurpaska, M. Chmielewski, M. Frelek-Kozak, M. Wilczopolska, K. Mulewska, M.M. Zieliński, Ma. Kowal, R. Diduszko, W. Chromiński, J. Jagielski, Microstructure and phase investigation of FeCrAl-Y <sub>2</sub> O <sub>3</sub> ODS steels with different Ti and V contents, J. Nucl. Mater.[100] Vol. 586 (2023) 154700
E. Wyszowska, C. Mieszczyński, Ł. Kurpaska, W. Chromiński, A. Azarov, I. Jóźwik, A. Esfandiarpour, A. Kosińska, D. Kalita, R. Diduszko, J. Jagielski, S. Nori, M. Alava, The Fe addition as an effective treatment for improving the radiation resistance of fcc NiFe <sub>1-x</sub> single-crystal alloys, J. Nucl. Mater.[100] Vol. 584 (2023) 154565
W. Zhu, W. Huo, S. Wang, Ł. Kurpaska, F. Fang, S. Papanikolaou, H. Kim, J. Jiang, Machine Learning-Based Hardness Prediction of High-Entropy Alloys for Laser Additive Manufacturing, JOM Vol. 75, pages 5537–5548 (2023)
I. Jóźwik, J. Jagielski, P. Ciepielewski, E. Dumiszewska, K. Piętak-Jurczak, M. Kamiński, U. Kentsch, Depth-distribution of resistivity within ion-irradiated semiconductor layers revealed by low-kV scanning electron microscopy, MAT SCI SEMICON PROC[70] Vol. 165 (2023) 107640
M. Marciszko-Wiackowska, A. Baczmanski, Ch. Braham, M. Wątroba, S. Wroński, R. Wawszczak, G. Gonzalez, P. Kot, M. Klaus, Ch. Genzel, Stress evolution in plastically deformed austenitic and ferritic steels determined using angle and energy-dispersive diffraction, MATER CHARACTER[100] Vol. 203 No 113114 (2023)
K. Suchorab, M. Gawęda, A. Kosińska, D. Kalita, I. Jóźwik, Ł. Kurpaska, Understanding the role of the tetragonal phase in oxidation behaviour of different zirconium-based alloys in air and water vapour conditions – Phase fraction and stress field distribution, MATER CHARACTER [100] Vol. 205 (2023) 113373
P. Kot, M. Wroński, A. Baczmanski, A. Ludwik, S. Wroński, K. Wierzbanski, Ch. Scheffzük, J. Pilch, G. Farkas, A novel method of experimental determination of grain stresses and critical resolved shear stresses for slip and twin systems in a magnesium alloy, MEASUREMENT [200] (2023) Vol. 221, 113469
D. Kalita, I. Jóźwik, Ł. Kurpaska, K. Mulewska, W. Chromiński, J. Jagielski et al., The microstructure and He+ ion irradiation behaviour of novel low-activation W-Ta-Cr-V refractory high entropy alloy for nuclear applications, Nuclear Materials and Energy[140] Vol. 37 (2023) 101513
Mark Fedorov, Jan S. Wróbel, Witold Chromiński, Grzegorz Cieślak, Magdalena Płocińska, Krzysztof J. Kurzydłowski, Duc Nguyen-Manh, Composition stability of single fcc phase in Cr–Fe–Mn–Ni alloys: First-principles prediction and experimental validation, Acta Materialia Volume 255, 15 August 2023, 119047
R. Alvarez-Donado, S. Papanikolaou, A. Esfandiarpour, M. Alava, Viewing high entropy alloys through glasses: Linkages between solid solution and glass phases in multicomponent alloys, Phys Rev Mat[70] Vol. 7 No 025603 (2023)
Q. Xu, A. Zaborowska, K. Mulewska, W. Huo, K. Karimi, F. Dominguez, Ł. Kurpaska, M. Alava, S. Papanikolaou, Atomistic insights into nanoindentation-induced deformation of $\alpha$ -Al <sub>2</sub> O <sub>3</sub> single crystals during nanoindentation, Vacuum, Volume 219, Part A, January 2024, 112733
Małgorzata Lubas, Anna Zawada, Jarosław Jan Jasinski, Adrian Nowak, Experimental Study of Amphibolite–Basalt (SiO <sub>2</sub> -Al <sub>2</sub> O <sub>3</sub> -CaO-Fe <sub>2</sub> O <sub>3</sub> ) Glasses for Glass-Ceramic Materials Production, Materials 2023, 16(21), 6887
H. Salmenjoki, S. Papanikolaou, D. Shi, D. Tourret, C. M. Cepeda-Jiménez, M. T. Pérez-Prado, L. Laurson & M. J. Alava, Machine learning dislocation density correlations and solute effects in Mg-based alloys, Scientific Reports volume 13, Article number: 11114 (2023)

# Selected CoE NOMATEN Scientific Seminars in 2023

Alicja Stankiewicz, Coat-it sp. z o.o, Coating technology in industry – Functional Properties of Materials
Martin Hruby, Institute of Macromolecular Chemistry, Czech Academy of Sciences, Biocompatible stimuli-responsive supramolecular polymer systems as promising radionuclide vectors for medicine– Radiopharmaceuticals
Javier Llorca, IMDEA, Strategies for materials design from atomistic simulations – Materials Structure, Informatics and Functions
Alison Davenport, University of Birmingham, Strategies for materials design from atomistic simulations
Marian Paluch, University of Silesia, Insight into molecular dynamics behavior of glass-forming liquids from experiment and MD simulations – Complexity in Functional Materials
Nathalie Moncoffre, IP2i, Study of He and Li diffusion in B4C – Role of damage – Materials Characterization
Coraline Hossepied, DRMP/SEMI/LM2E, Nuclearization of atom probe tomography and the workflow analysis: Atomic-scale characterization of neutron irradiated materials. – Functional Properties
Bernard Maillere, CEA / JOLIOT / DMTS, The varied landscape of the therapeutic antibodies – Radiopharmaceuticals
Stéphanie Simon, CEA / JOLIOT / DMTS, Antibodies dedicated to in vitro diagnosis – Radiopharmaceuticals
Anna Frackiewicz, Ecole de Mines, Saint-Etienne, HEA/MEA - Functional Properties
Charles Truillet, CEA / JOLIOT / SHFJ, Antibody-based radiopharmaceuticals - Radiopharmaceuticals
Jaakko Akola, Norwegian University of Science and Technology, Memory Materials - Complexity in Functional Materials
Cesare Franchini, University of Vienna, Computational Modelling of Quantum Oxides - Material informatics
Marie Landeiro, La Rochelle University, About the formation of vacancy clusters in FCC materials: An atomistic approach - Material Complexity
Clara Desgranges, CEA, Challenges and advances in computational materials design - Material Complexity
Alexandre Semerok, CEA, Challenges and advances in computational materials design - Functional Properties of Materials
Prof. Stanisław Stupkiewicz, IPPT-PAN, Phase-field modelling of microstructure evolution in displacive transformations - Materials Complexity
Denis Servent, CEA-SIMoS-Saclay, Structural and functional diversity of venom toxins interacting with GPCRs – Radiopharmaceuticals
Mattias Thuvander, Chalmers University, Sweden, Atom Probe Tomography Studies of Nuclear Materials - Functional properties of materials



# COE NOMATEN TEAM DEVELOPMENT

## Our Team

The growth of NOMATEN research capacities has continued. All five groups have been actively recruiting for scientific projects, and the current research staff is 46 (16 women, 30 men), with 69% under 35 years of age. Moreover, there is an ongoing campaign to strengthen our support staff as staff scientists (Aleksandra Baron-Wiecheć MSCA grant on corrosion is supported by two hired experts; recruitments for CERAD support). Other supporting staff includes help with procurement and grant application support.

We have seen growth in the institute after the COVID-19 pandemic; there has been an increase in staffing in 2023. Following the COVID-19 experience, the new hybrid working model has enabled participation in many more hybrid meetings. We created a common Share Platform, providing easier access to materials and tools, contributing to more effective knowledge sharing and building a know-how base.



## We aspire excellence to in employment

We continue HR excellence. We have applied for another project to support international staff for the current Welcome Point. We have expanded with further activities and joined the EURAXESS global network to support researchers. EURAXESS is a true resource for our researchers, offering leadership support, the exchange of good practices, and access to training and activities organised by international network members.



## Supporting the team

At NOMATEN, the pursuit of excellence begins with our people. Since its inception, NOMATEN has prioritized the Hospitality Manager role as an integral part of our team. Today, we have a dedicated team of two professionals who warmly welcome our international colleagues.

### Pioneering Best Practices

Our commitment to excellence extends to all aspects of our organization. With the support of our partners from VTT and CEA, we have leveraged best practices and extended them throughout the National Centre for Nuclear Research (NCBJ). In 2021, we established the Welcome Point (WP) as part of the NAWA „Welcome To Poland” program, setting the gold standard for welcoming international talent.

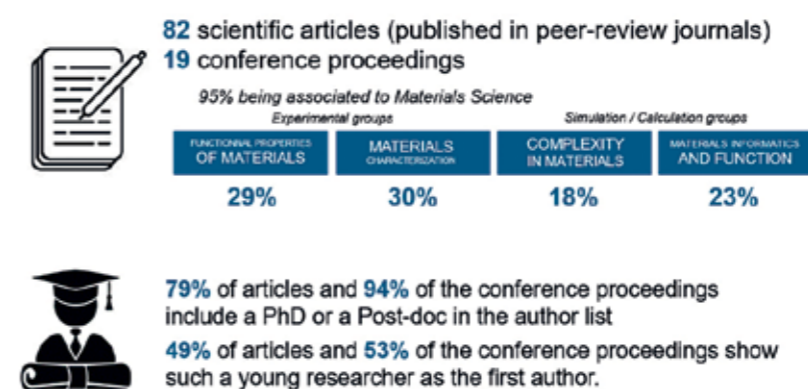
### Tailored Support for Diverse Needs

WP is staffed by a team of four experts located in two offices - Świerk-Otwock and Warsaw. Our research institute houses diverse individuals, each with unique needs, from scientists to doctoral students. That's why we've adopted a customer-centric approach, tailoring our support to each individual's requirements with a fancy Welcome Centre.

### Beyond the Basics

Our services go beyond the ordinary. We assist with visa applications for short- and long-term residence permits and guide you through Poland's registration and deregistration process. Additionally, WP assists foreign nationals and their families with relocation, helping them find accommodation, open bank accounts, and set up mobile services. We also offer valuable information on social insurance, healthcare, and childcare and provide a wide array of training programs, including Polish language courses and workshops to immerse foreigners in Polish culture and traditions.

### YOUNG RESEARCHERS GENERATION!



## Welcome to NOMATEN - Poland: Your Path to Excellence

### Impressive Growth and a Global Perspective

Since we began organising support for foreign nationals, our Institute has seen a nearly twofold increase in international talent, growing from 45 individuals to 82 (including employees and doctoral students). At the beginning of NOMATEN operations (15 months), there were only 6 non-Polish employees. Currently, there are 19 people. Alongside our successes in legalizing foreign nationals' stay, WP is pivotal in implementing NCBJ's communication strategy and enhancing the Institute's internal and external image. Our goals are expansive:

- 1. Fostering Internationalization:** We recognize how we treat foreign nationals, which is crucial in attracting top talent. Internationalization appeals to young scientists, including our Polish colleagues, in a competitive job market. Working within a multicultural team and collaborating with peers worldwide are distinct advantages at NCBJ.
- 2. Cultivating Cultural Change:** At NOMATEN, we value diversity and prioritize genuine openness and inclusivity. Our institute is an expert centre that supports staff and managers in overcoming cultural and language differences and challenges. We embrace diversity as a core strength, creating an environment where individuals feel comfortable and heard and can share their unique experiences.
- 3. Building Partnerships and Expertise:** WP has evolved into an expert centre for employing foreign nationals, handling recognition procedures, and streamlining the process of legalizing stays in Poland. Our network extends to officials, fellow Welcome Centres in Poland, and individuals and foundations dedicated to working with foreign nationals.

We've actively participated in initiatives like HR Excellence (National Contact Point) and the „Solidarity with Ukraine” program, demonstrating our commitment to excellence.

We participated as panellists in the conference „Welcoming universities: Towards high-quality support for international academics in Central-Eastern and South-Eastern Europe”, 21 June 2023, Bratislava, Slovakia – organized by UniWeliS project consortium, Euroaxess and Ministry of Education, Science, Research and Sport of the Slovak Republic. Panel discussion: „How to advance in building a welcoming environment towards international campus – best practice at policy, programme and institutional level”

### Join Us at NOMATEN

At NOMATEN, we believe in the power of people. Our collective dedication and diverse perspectives drive our journey towards excellence. If you're seeking a workplace where your unique contributions are celebrated, internationalization is embraced, and professional growth is paramount, then welcome to NOMATEN.

Discover your path to excellence with us.

## CoE NOMATEN Human Resources

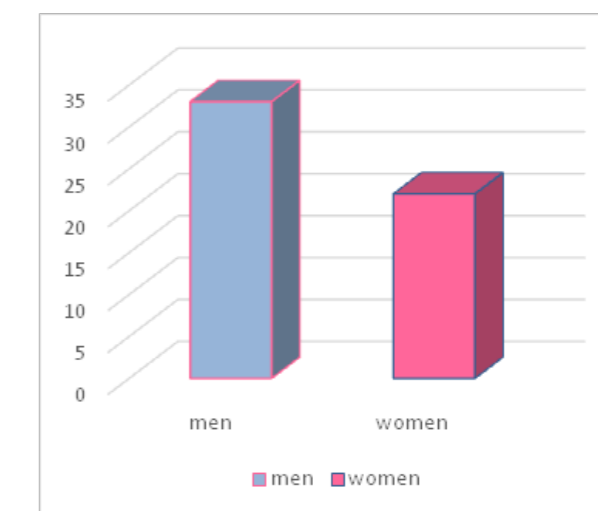
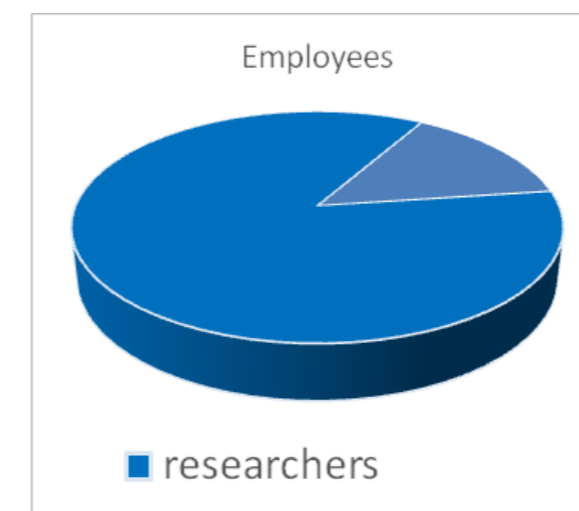
Status - December 31, 2023

Personnel: 55 people. Average age: 36.

Researchers: 47 people (85%)

Women: 22 (40%)

Men: 33 (60%)



Position type	Total number	Number of Internationals
Team Leaders	5	2
Post docs	15	4
PhD students	15	8
Senior Post-docs	2	1
Technicians	8	8
IT staff	3	0
Administration	7	0

University Level degree: 95%

Doctorate Level: 56%

Nationality: 41% internationals, 12 nationalites

Azerbaijan – 2  
China – 2  
Finland – 1  
France – 2  
Greece – 1  
India – 1

Iran – 3  
Italy – 2  
Lebanon – 1  
Mexico – 1  
Poland – 37  
Ukraine –

# COE NOMATEN EVENTS IN 2023

## NOMATEN Innovation Days

NOMATEN Innovation Days was an industry-oriented event focused on companies' expectations, needs and experiences regarding R&D projects and scientific services. NOMATEN Centre of Excellence is an international research organization dealing with different aspects of innovative materials for the future industry. We are based at Poland's National Centre of Nuclear Research (NCBJ) and have extensively partnered with the VTT Technical Research Centre of Finland and the French Alternative Energies and Atomic Energy Commission (CEA).

NOMATEN aims to learn about companies' needs and demand for research services. Representatives of all industry sectors are welcome to attend the event and learn about the collaboration opportunities.

The first day, 24 May, was dedicated to the nuclear industry—materials research, research services, and requirements and expectations for companies entering nuclear projects. The second day, 25 May, was dedicated to issues related to general engineering (e.g., materials research and radiography in the chemical, energy, automotive, and metallurgical industries, etc.).



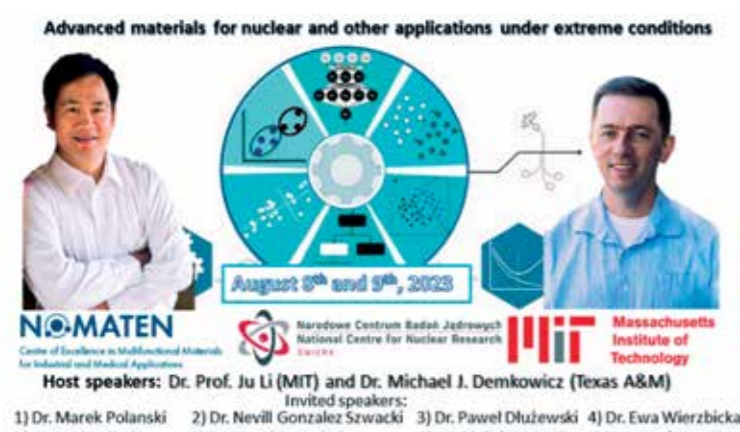
## Workshop on Advanced Materials for Nuclear and Other Applications under Extreme Conditions

Centre of Excellence NOMATEN organized the International Workshop on Advanced Materials for Nuclear and Other Applications under Extreme Conditions on August 8-9th, 2023. The event was a hybrid event, providing in-person and virtual participation options.

The primary aim of this event was to foster scientific collaborations between the United States and Poland. It brought together experts and researchers in materials science, specifically related to nuclear research and extreme operating conditions. The Workshop encompassed various topics relevant to materials science, ranging from numerical simulations to experimental exploration.

We were honoured to have the distinguished presence of Prof. Ju Li from MIT and Dr. Michael J. Demkowicz from Texas A&M University as the keynote speakers, adding significant value to the Workshop.

By attending this Workshop, participants gained valuable insights into the current state of international materials science research. Presentations from renowned researchers covered various subjects. After each presentation, attendees could engage in interactive question-and-answer sessions by writing questions or using a microphone.



## Workshop on Complex Glasses

Centre of Excellence NOMATEN organized the 1st International Workshop on Complex Glasses on October 17-19th 2023. This Workshop was intended to bring together glass researchers from different backgrounds and fields and discuss the latest developments in this area. The program included contributions from experimental research, including examples of novel synthesis routes and characterization techniques, as well as theoretical and design approaches to tackle the challenges posed by these complex materials.

Metallic glasses have long been a promising direction in materials research. The field faces various questions, including how to understand their atomic structure, make them in bulk, design alloys with specific properties, and study their mechanical behaviour.

The Workshop was co-organized with the University of Silesia in Katowice and Industrial Partner – Amazemet Company, a Warsaw University of Technology spin-off company. The company was created due to challenges faced by its founder – Łukasz Żrodowski – during his research on metallic glasses 3D printing when it turned out that solutions created in the process might also help other researchers. Offered products aim to create new possibilities in materials development, especially metallic powders and metal additive manufacturing.

The visit to the company's additive manufacturing laboratory featured a guided walk around the facility, but most importantly, a live ultrasonic atomization process of metal powder was performed on a rePowder, device, or metal 3D printing process with the use of Aconity 3D printer. It was also a great chance to discuss how ultrasonic atomization makes the production of small batches of metallic glass powder possible for research purposes or challenges with metallic glass 3D printing. The tour was guided by AMAZEMET application engineers and PhD candidates whose everyday work is focused on metal powder production and additive manufacturing.



**First International Workshop on Complex Glasses**  
17-19 October  
2023 Warsaw

Workshop Organizers



Industrial Partners



## CoE NOMATEN Winter School 2023

The third international CoE NOMATEN School was held from November 28 to 30, 2023, at the National Center for Nuclear Research in Otwock/Warsaw. It was devoted to functional materials for industrial applications and novel radiopharmaceuticals for medical applications. CoE NOMATEN School was an internal collaboration event for NOMATEN consortium partners (NCBJ, CEA, VTT), enabling team members to exchange knowledge and ideas on new developments and industrial solutions within the NOMATEN project.

The preliminary program of the Winter School 2023 included topics related to the synthesis of new materials, modelling in materials engineering, material characterization and advanced solutions in radiopharmaceuticals and medical therapies. A rich program has been planned for the participants of the NOMATEN winter school, including participation in plenary presentations and thematic sessions realized by experienced researchers, as well as sessions for young scientists and poster sessions. The last day included presentations on large scientific infrastructure projects implemented at NCBJ (Polfel, Neutron irradiations in MARIA Reactor) and visits to NCBJ Laboratories, including the Materials Research Laboratory, the XRay Lab and the SEM and TEM Microscopy Laboratory. At the same time, during the Winter School, Participants will also learn about theoretical and practical methods of intellectual property protection and patenting new scientific solutions as part of the intellectual property rights and protection, including training, which experts from CEA and VTT conducted.

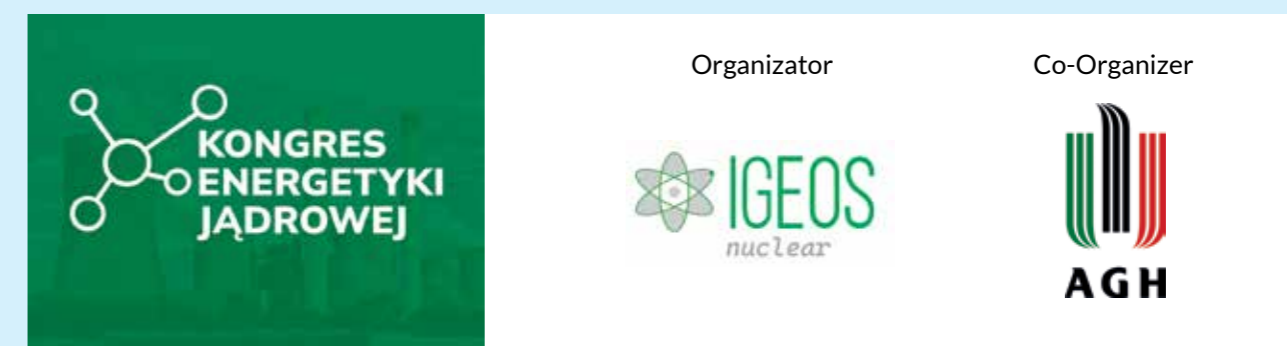


# INDUSTRIAL EVENTS PRESENCE AND JOINED ASSOCIATIONS

## SELECTED MAIN INDUSTRIAL EVENTS

### 1st Nuclear Power Industry Congress, September 12-13, 2023

A significant event in which CoE NOMATEN (VTT and NCBJ CoE Team) participated was the 1st Nuclear Power Industry Congress "How to become a leader in the development of nuclear energy in the region" held on September 12-13, 2023, at AGH University – IT Solutions Centre in Cracow. This was the first event in our country that comprehensively affected the plans for developing nuclear energy in Poland, both in terms of large-scale projects and MMR/SMRs, as well as the benefits of these projects for the Polish energy industry (business). The Congress was a place for dialogue for ministers, decision-makers, investors, senior officials and industry experts, higher education and vocational education centres, technology providers and the Polish industry.



The ceremonial opening was performed by Mr. Adam Guibourgé-Czetwertyński, Secretary of State at the Ministry of Climate and Environment, emphasizing the importance of projects for the construction of nuclear power plant units in the process of transformation of the Polish energy sector and energy security. The aim of the Congress will also be to show how nuclear energy and the Polish Nuclear Energy Program (PPEJ) can contribute to implementing the PEP2040 goals, including achieving transformation in Poland as an effective way to decarbonize energy supply in the power system. The main objective of the Congress was also to discuss the main issues related to supporting Polish companies in implementing nuclear energy projects in Poland. During the Congress speech by Andrzej Sidło, Counselor of the Minister at the Ministry of Climate and Environment, focused the participants' attention on the government's activities regarding support for the Polish industry. The Counselor pointed out what Polish entrepreneurs can count on in connection with the development of the nuclear energy sector, what are the roles and tasks of state administration institutions, including the Ministry of Environmental Protection, on the way to maximizing the participation of domestic entities in the Polish Nuclear Energy Program. During Congress essential panel was also connected with Human resources in Nuclear Power Industry held by Paweł Gajda - Vice-President of the European Nuclear Society (ENS), Faculty of Energy and Fuels, AGH and Marcin Kardas, Deputy Director for Innovation, National Center for Nuclear Research (NCBJ) CoE NOMATEN, which indicated tools for acquiring human resources, including professionals, engineers and research staff with high competences and knowledge in the field of nuclear energy. The valuable part of the congress was also a technical workshop presenting advanced techniques/technologies in the nuclear sector: project modularization, application of BIM, megaproject management, and advanced welding technologies used in the nuclear power sector.

## 3rd Conference Atom for Poland

CoE NOMATEN took part in the third edition of the Atom for Poland Conference, which took place on September 19, 2023 in Warsaw at the Faculty of Management of the University of Warsaw. During the conference, there was a debate on the place of nuclear energy in the Polish Energy Program 2040 and cooperation between the worlds of science and business. The discussion also concerned financing large-scale nuclear energy solutions and SMR and building local content. In Poland, analyses are underway on the feasibility of SMR modular reactors and preparatory work for constructing three large power plants. The most advanced project is planned in Pomerania and implemented by Polskie Elektrownie Jądrowe, established by the State Treasury with Westinghouse as the partner. A decision has still not been made regarding the technology for building the second land-based nuclear power plant under the government program for which the French company EDF submitted an offer. Presenting the offer at the conference, Thierry Deschaux, General Director of the EDF Representative Office in Poland, assured that it meets Polish requirements and is competitive. Director Deschaux assured that the offer for Poland is integrated - so the investor has one partner for negotiations - and covers the full scope of work: technology supply, design, construction and start-up support - as well as operation and maintenance. During the session, the General Director of the EDF Representative Office in Poland drew attention to the importance of nuclear power plants in producing zero-emission energy, and he recalled that in 2020, they provided 42% of such energy in the European Union. He believes that the life of existing power plants should be extended, and a decision should be made to build new ones to replace those decommissioned in 20-30 years. Not only France plans to build at least 6 new reactors, but also the Czech Republic, Slovakia, Slovenia, Finland and Sweden, so the perception of nuclear energy has changed over the last two years. According to Deschaux, to quickly decarbonize the energy mix in Poland, it is necessary to replace large coal-fired power plants - especially Bełchatów and Turów. Moreover, Philippe Bordarier, director of nuclear energy of the Polish Nuclear Power Plants, mentioned key infrastructure projects accompanying the construction of a nuclear power plant in Pomerania, the implementation of which is carried out in cooperation with other stakeholders, including the National Roads Authority (GDDKiA), PKP PLK [operator of the railway network] or the Maritime Office in Gdynia. These essential projects include access roads, railways and marine facilities. According to Andrzej Sidło, legal advisor to the Ministry of Climate and Environment, although many challenges are related to constructing nuclear power plants, we have already implemented most national regulations. Great emphasis will be placed on the issues of creating personnel for the nuclear power industry in Poland - both large-scale and SMR. The period of training new employees for the emerging nuclear sector in Poland coincides with the time of preparation for constructing nuclear power plants in selected locations. There is a need to determine the short-, medium-, and long-term needs and prospects for the preparation of personnel to ensure a high level of internationalization, including through the internship system in Europe, South Korea, and the USA. At this year's conference, the education system and the training of graduates at existing nuclear power plants were also discussed.



## Symposium Polish pumps and fittings for nuclear energy 2023

On October 4-5 2023, in Jachranka (near Warsaw), CoE NOMATEN representatives from VTT and NCBJ participated in the symposium „Polish pumps and fittings for nuclear energy.” The main aim of the symposium was to discuss and get acquainted with the technical, formal and legal conditions for the entry of Polish enterprises, including manufacturers of pumps and fittings, into the supply chain for the Polish nuclear program. The meeting was widely reported and attracted nearly 100 pump and fitting manufacturers from all over the country, presenting devices and formal and legal exits in the supply chain for the Polish nuclear programme. On the first day of the conference, it was possible to obtain information on the effect of the nuclear programme on the impact on the pumps and valves suppliers and the requirements they should fulfil in the nuclear power supplier's chain (presentations and discussions held by the Department of Nuclear Energy Ministry of Climate and Environment, the Office of Technical Inspection, Westinghouse, EDF, GE Hitachi and Bechtel. The next day, representatives of potential suppliers for nuclear projects presented their already made actions and deliveries for the nuclear sector: Powen-Wafapomp SA Group, ANGA Uszczelczenia Mechaniczne Sp. z o. o., Fabryka Armatury Przemysłowej Wakmet Sp. z o. o., Zetkama, Zamkon, Zakład Automatyki Polna SA, Auma Polska Sp. z o. o. The Polish Association of Pump Manufacturers and Industrial Fittings (SPAP) organised the symposium. The SPAP Association's fundamental aim is to promote Polish industrial valves and the concentration of Polish pumps and valve producers to be more effective in facing the competition of foreign companies and manufacture better quality products.



## Associations Joined

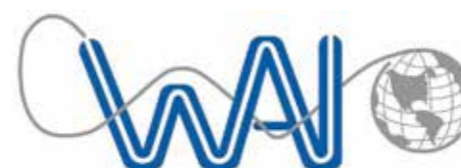


The Centre of Excellence NOMATEN has recently joined significant associations with which we plan to carry out events and prepare trainings, research and development projects in cooperation with association member companies.

**The European Committee for Standardisation CEN** is a vital organization, which CoE joined for the **WS64 workshop on Design and Construction Codes for Gen II, III and IV nuclear facilities (Phase III and IV)**. Meetings within the CEN WS64 network aim to create a community of European nuclear code experts and enable European operators to use AFCEN codes for their needs (long-term operations, spare parts, new reactors) in their local context. The workshop intends to engage this preparation, assuming that many European stakeholders will be involved in evaluating different types of reactors, among which AFCEN code-based reactors, particularly during the bid process. Consequently, the CEN/WS 64 is a convenient opportunity for these stakeholders to get familiar with the standardization process through the AFCEN codes and to learn how to customize them to comply with their specific needs. The proposer of the Workshop is AFCEN, and the administrative holder of this workshop is AFNOR, the French National Standardization Body.



Another significant association is the **Polish Economic Chamber of Energy and Environmental Protection (IGEOS)**, a self-governing business organization representing Polish energy companies, a leading business integrator and an essential partner for industry and politics in developing effective changes in the Polish energy sector. Currently, the Chamber brings together around 100 member companies, including power generators, planning and design companies, equipment manufacturers for power generation and environmental protection, construction and engineering companies, service and trading companies, consulting, law firms and others. IGEOS Provide cooperation and advisory support to the Parliament, relevant ministries, the Presidential Administration and other state bodies in the preparation of regulations concerning the energy sector in Poland, following EU directives, and support investment projects in conventional energy, promote renewable energy sources, support cogeneration as an efficient way of producing electricity and heat, support the development of the nuclear programme in Poland.



**Wire Association International (WAI), Inc.**, founded in 1930, is the worldwide technical association for wire and cable professionals. Headquartered in Madison, Connecticut, USA, WAI collects and provides technical, manufacturing and general business information for the wire and cable industry's ferrous, non-ferrous, electrical, fibre optic and fastener segments. WAI has chapters throughout the US, India, Italy and Poland to provide membership in regional professional communities. Chapters provide members with insight into both local and global wire and cable industry issues through educational programmes and social events, which also provide networking opportunities at a regional level. The Polish Chapter of WAI Association aims to work for and promote the development of the Polish metal products, wire and cable industry and other related industries while collaborating with the world's leading centres in this field.



**Advanced Materials Initiative 2030 (AMi2030)** is an open and inclusive forum seeking to transform the European Advanced Materials sector sustainably. To do so, a common and shared framework for all Advanced Materials stakeholders is proposed. By integrating all strands of stakeholders, from upstream developers, manufacturers, downstream users, citizens and all stakeholders in between, the initiative covers the full range of the advanced materials value chain and considers the different needs and challenges along the innovation cycle. This Strategic Materials Agenda (SMA) is intended to feed into the discussions between the European Commission and Member States on the development of the Coordinated Plan of Action on advanced materials. Thanks to their specifically engineered properties designed to exhibit novel and outstanding functionality, Advanced Materials play an important - often critical - role in the green and digital transition while simultaneously reinforcing Europe's strategic sovereignty.



**NOMATEN Centre of Excellence  
National Centre for Nuclear Research, Poland**



ul. Andrzeja Sołtana 7  
05-400 Otwock - Świerk  
Poland



[nomaten.ncbj.gov.pl](http://nomaten.ncbj.gov.pl)



[linkedin.com/company/nomaten](https://www.linkedin.com/company/nomaten)



[twitter.com/nomaten\\_ncbj](https://twitter.com/nomaten_ncbj)

**Prof. Mikko Alava**  
NOMATEN CoE Director



[mikko.alava@ncbj.gov.pl](mailto:mikko.alava@ncbj.gov.pl)

**Prof. Paweł Sobkowicz**  
Director for Scientific Operations



[pawel.sobkowicz@ncbj.gov.pl](mailto:pawel.sobkowicz@ncbj.gov.pl)

**Prof. Jacek Jagielski**  
NOMATEN CoE Teaming Coordinator



[jacek.jagielski@ncbj.gov.pl](mailto:jacek.jagielski@ncbj.gov.pl)