INSTITUT JEAN LAMOUR

cnrs

UNIVERSITÉ DE LORRAINE

2025

yearbook

Edito

Prof. François **Montaigne**

Director of IJL

The Institut Jean Lamour is distinguished by the breadth and diversity of its scientific community, bringing together a large number of researchers and academic staff from multiple disciplines around a common scientific focus: materials science. The various publications highlighted in this yearbook provide a representative overview of the major scientific advances achieved by the laboratory's groups in 2025, in particular in the areas of thermoelectric materials, metamaterials, carbon-based materials, hydrogen-related research, and spin electronics. Consistent with the Institute's commitment to open science, the full corpus of research outputs produced by the laboratory is made publicly available through the laboratory's HAL repository.

This limited-length document is, by its nature, not exhaustive. It could also have mentioned the interns we had the pleasure of welcoming (more than 180), acknowledged the colleagues who generously gave seminars (50), listed all the projects that were launched (and those that will have to wait!), as well as the many actions undertaken in the areas of safety, inclusion, well-being at work and much more besides. Above all, this necessarily slim selection can only imperfectly reflect the tremendous day-to-day efforts carried out by all members of our scientific groups, core facilities, and support services. They are the primary asset of our laboratory, and I would like to warmly commend their dedication and commitment.

I nevertheless hope that these few pages convey our shared joy and happiness in doing science and in sharing it.

In Numbers

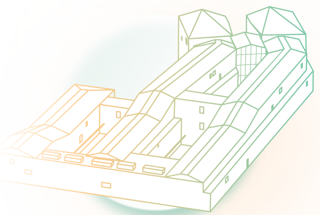
The Institut Jean Lamour (IJL) is a fundamental and applied research laboratory in material science. It is a joint unit (UMR 7198) of the **CNRS** and **Université de Lorraine** and it is attached to the **CNRS Institute of Chemistry**.

IJL is a multi-thematic laboratory covering **materials, metallurgy, nanosciences, plasmas, surfaces and electronics** in response to societal challenges such as **energy, environment, the industry of the future, mobility, the preservation of resources** and **health**.

Its research work ranges from the design of materials to their industrial applications.

254 permanent staff

150 PhD students



30 000 m² building

600 equipment

8 core facilities

320 publications per year

24 research groups

Four Departments

The IJL's research work is carried out by **24 groups**, organized into **4 scientific departments** and **a technological research team**.

It is supported by **8 core facilities** and **4 support services**.

P2M – PHYSICS OF MATTER AND MATERIALS

The P2M department consists of 5 research groups and 49 permanent staff members.

It develops fundamental knowledge in physics, matter and materials with a strong focus on magnetism and nano-electronics to support technological advances at the smallest scales. In parallel, the department investigates next-generation energy solutions.
The research focuses on magnetism, spintronics, electronic properties of thin surfaces, physical properties of intermetallic materials, optical properties of semiconductor nanostructures, spintronics in semiconductors, and fusion plasmas.

CP2S – CHEMISTRY AND PHYSICS OF SOLIDS AND SURFACES

The CP2S department brings together 8 research groups and 65 permanent staff members.

Its activities cover engineering, synthesis and characterization of advanced materials and surfaces with functional properties.
It concerns surface treatments by plasma processes, surface sciences, corrosion at high and low temperature, thermoelectricity, carbon materials, civil engineering and electrochemistry to gain basic knowledge on materials and surface for developing applications in two important sustainable development goals: energy and recycling.

SI2M – MATERIALS SCIENCE, ENGINEERING AND METALLURGY

The SI2M department includes 4 research groups and 36 permanent staff members.

It aims to master the full value chain of materials by controlling their elaborations, formulations, compositions and microstructures to achieve targeted mechanical properties and reliability.
Combining multiscale experimentation and modeling, it strives to optimize manufacturing processes, design advanced metallic alloys, polymers and composites for structural and functional applications, to address challenges in decarbonization, lightweighting, energy and environmental transitions, health and circularity.

N2EV – NANOMATERIALS, ELECTRONICS AND LIVING

The N2EV department emcompasses 6 research groups and 44 permanent staff members.

It conducts research across a broad spectrum of fields, including nano and biomaterials for health, bio-sourced materials, lab-on-chip technologies, micro- and nanosystems, metamaterials and phononics, as well as electronic architectures and systems.
Its research activities align with several major societal priorities such as materials for the future, energy efficiency, industrial renewal, environmental protection and energy transition, in addition to health and well-being.

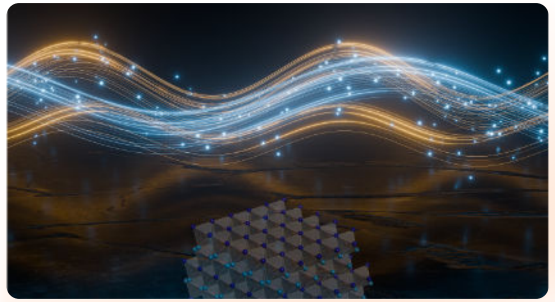
Publications

Nature Communications

Hidden in plain heat: anomalous Lorenz number in the thermoelectric alloy $Bi_{0.4}Sb_{1.6}Te_3$

Christophe Candolfi, Bartlomiej Wiendlocha, Viktoriia Ohoridniichuk, Petr Levinsky, Sylvie Migot, Gwladys Steciuk, Ilayda Terzi, Arthur Wieder, Anne Dauscher, Soufiane El Oualid & Bertrand Lenoir

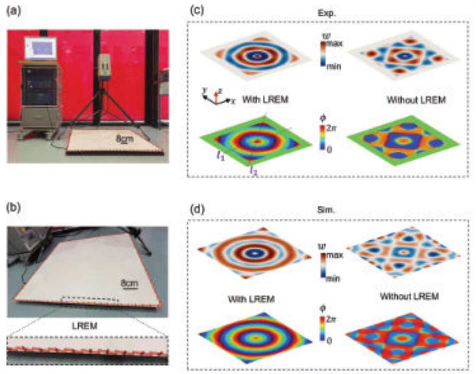
$Bi_{0.4}Sb_{1.6}Te_3$ belongs to the family of thermoelectric materials used in commercial Peltier cells. Several studies have suggested that its performance could be improved by an ultrafast quenching technique, known as melt-spinning, that induces nanostructuring of the samples. However, our results challenge this scenario by showing that samples obtained using this technique exhibit a lattice thermal conductivity similar to those manufactured conventionally, contrary to what was previously assumed. Our study reveals that complex, inelastic scattering processes between electrons and optical phonons drive an anomalous temperature dependence of the Lorenz number, which cannot be predicted by conventional transport models, explaining the erroneous conclusions drawn in prior studies.



Advanced Materials

Elastic Absorbing Metagrating

Liyun Cao, Sheng Wan & Badreddine Assouar



Optical and acoustic metagratings have addressed the challenges of low-efficiency wave manipulation and high-complexity fabrication associated with metamaterials and metasurfaces.
In this research, entirely developed in the « Metamaterials and Phononics » group of IJL, the concept of locally resonant elastic metagrating (LREM) is both theoretically and experimentally demonstrated, which is underpinned by the unique elastic impedance modulation and the hybridization of intrinsic evanescent waves. Remarkably, the LREM overcomes the size limitations of conventional metagratings and offers a distinctive design paradigm for highly efficient, compact, and lightweight structures for wave manipulation in elastic wave systems.
Importantly, the LREM tackles a key challenge inherent to all elastic wave-manipulation metastructures, which consists in the unavoidable vibration modes in finite structures hindering their real-world applications.

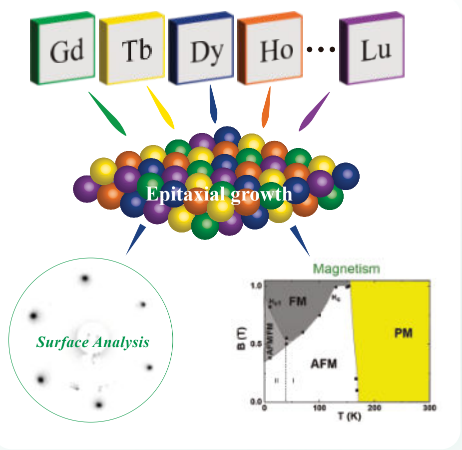
ACS Nano

Epitaxial Growth of Rare-Earth High-Entropy Alloy Thin Films

Julian Ledieu, Karine Dumesnil, Mélanie Emo, Sylvie Migot, Sorour Semsari Parapari, Sašo Šturm, Primož Koželj & Vincent Fournée

The growth of high-entropy alloy (HEA) thin films using the molecular beam epitaxy (MBE) technique widens our horizons in materials design. This technique offers precise control of key parameters (deposition rate, substrate orientation, interfacial, or lattice strain), and it becomes possible to study the interplay existing between the elemental choice, their respective stoichiometry, and the associated physical and chemical properties. Such fine-tuning of HEA with an immense compositional space will bring additional advanced materials with exotic properties.

Here, we report the epitaxial growth of a rare-earth (RE) HEA thin film on a buffer layer of Nb by MBE. The structure and chemistry of the DyGdHoLuTb thin film have been investigated in the bulk and at the surface under ultra-high vacuum (UHV) conditions, confirming a random chemical distribution on an ordered hexagonal closed-packed structure. We demonstrate how such a heterostructure exhibits magnetic properties that slightly depart from the magnetic phase diagram reported for polycrystalline materials of a similar system.

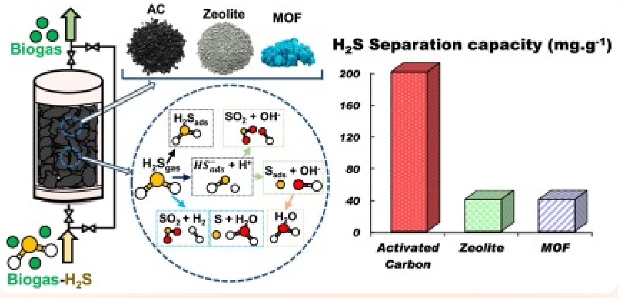


Chemical Engineering Journal

Activated carbons outperform other sorbents for biogas desulfurization

Luis Paz, Solène Gentil, Vanessa Fierro & Alain Celzard

This paper presents a literature review focusing on the separation of hydrogen sulfide (H2S) from biogas using activated carbon (AC), compared with other materials such as biochars, zeolites, metal–organic frameworks (MOFs) and metal-based adsorbents in terms of H2S separation capacity. The evaluation is carried out on different biogas compositions used to achieve breakthrough curves, including mixtures containing, in addition to H2S, methane (CH4) and carbon dioxide (CO2), air and inert gases. H2S adsorption mechanisms are presented and discussed. The article also includes a review of simulation studies on room-temperature H2S separation by adsorption columns.



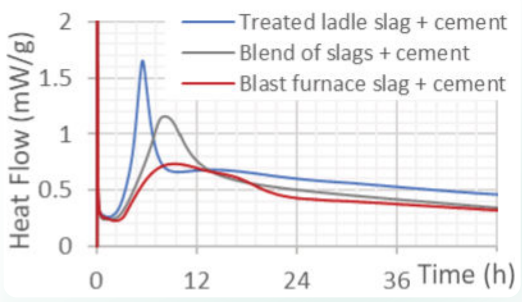
In addition, sorbent regeneration is addressed through a comparison in terms of degradation of separation performance. The results reveal that ACs, particularly when impregnated, outperform other sorbents in terms of H2S separation efficiency at room temperature. This research presents important information for optimizing the H2S removal process in biogas purification, thus contributing to the development of environmentally sustainable energy solutions.

Cement and Concrete Composites

Alternative binder for cemented paste backfill

Noureddine Ouffa, Tikou Belem, Romain Trauchessec, Cécile Diliberto, Pascal Lemoine, Youssef Benarchid & Mostafa Benzaazoua

In collaboration with the Institute on Mines and the Environment in Québec (UQAT), N. OUFFA's thesis focused on researching alternative binders for cemented paste backfills used to consolidate underground mines and store mine tailings at depth. This paper investigates binders containing ladle furnace slag and a waste product from a desulphurization process.



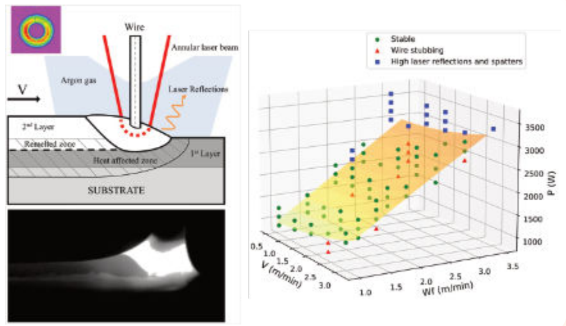
Thermal treatment and rapid cooling (quenching) at Québec metallurgy center allowed the amorphization of the ladle slag, which then contributes to the development of the backfill mechanical performance in various formulations. At IJL, the dissolution of the treated slag was subsequently studied in the presence of cement, blast furnace slag and the desulphurization residue. Pastes were also used to determine the impact of the treated slag on the heat of hydration (isothermal calorimetry, adjacent figure) and on hydration products of the binder. This study thus highlights the promising contribution of the treated slag and the desulphurization residue to the basicity of the interstitial solution, the formed hydrates, and the activation of the blast furnace slag.

Progress in Additive Manufacturing

Increasing the productivity of coaxial laser cold-wire additive manufacturing using Inconel 718

Ivan Cazic, Julien Zollinger, Maxime El Kandaoui, Maxime Schmitt, Julien Jourdan, Daniel Knispel & Benoît Appolaire

Laser and wire-based processes have shown strong potential for cladding and additive manufacturing of aerospace components. This study develops a process map for coaxial laser metal deposition using cold wire (LMD-W) through single-track experiments on Inconel 718. The effects of process parameters on track cross-sectional dimensions are examined, and multi-track walls are produced under various conditions without internal defects.



The influence of wire feed rate and energy density on build rate is analyzed, revealing the wire feed rate as the dominant factor; however, at constant feed rate, energy density becomes the key parameter, directly affecting both build rate and microstructure size. For a fixed wire diameter, comparisons with other technologies are made, and strategies for build-rate optimization via parameter tuning are explored. Cooling rates, estimated from primary dendritic arm spacing and verified through thermal imaging, range from to , depending on input energy. These findings position LMD-W as an intermediate process in terms of cooling rate and build rate within the additive manufacturing spectrum.

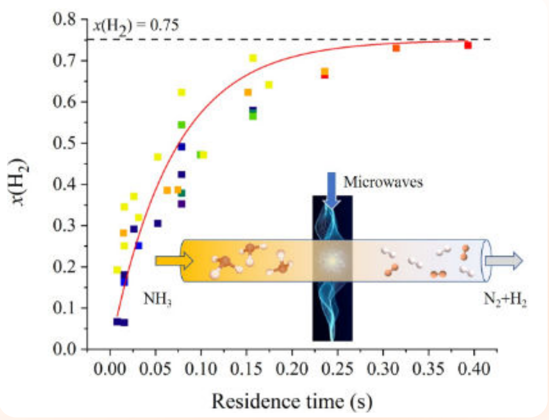
International Journal of Hydrogen Energy

Hydrogen production by plasma-assisted ammonia cracking

Majed Awaji, Lucile Pentecoste-Cuynet, Cédric Noël, Thomas Gries, Mohammed Belmahi & Thierry Belmonte

The cracking of pure ammonia by microwave discharges under reduced pressure (typically 50–500 mbar) is studied as a hydrogen formation process. The lowest energy cost associated with the production of 1 kg of hydrogen is 33 kWh (i.e. 13 % energy efficiency for a dissociation ratio of 28 %). With the same process, NH_3 can be fully dissociated at a slightly greater energy expense (50 kWh/kg H_2), which makes this way of producing H_2 viable economically.

We show that the molecule is dissociated thermally and by electron collisions, which explains partly the efficiency of the process, a part of the thermal energy being substituted by electric energy. We also show how some of the waste heat lost in this process can be recovered in post-discharge by activating surface reactions. With flowrates exceeding 10 L per minute, it is plausible that the process could be even more efficient by reducing the gradients that are responsible for the loss of energy efficiency.

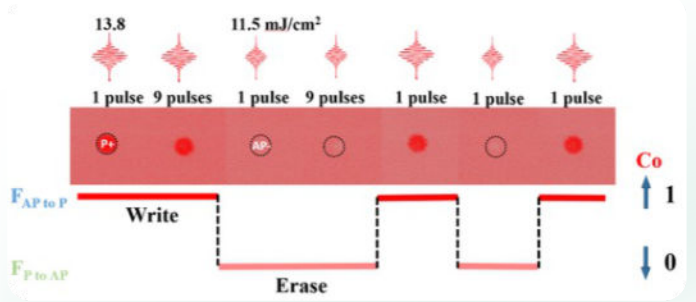


Advanced Functional Materials

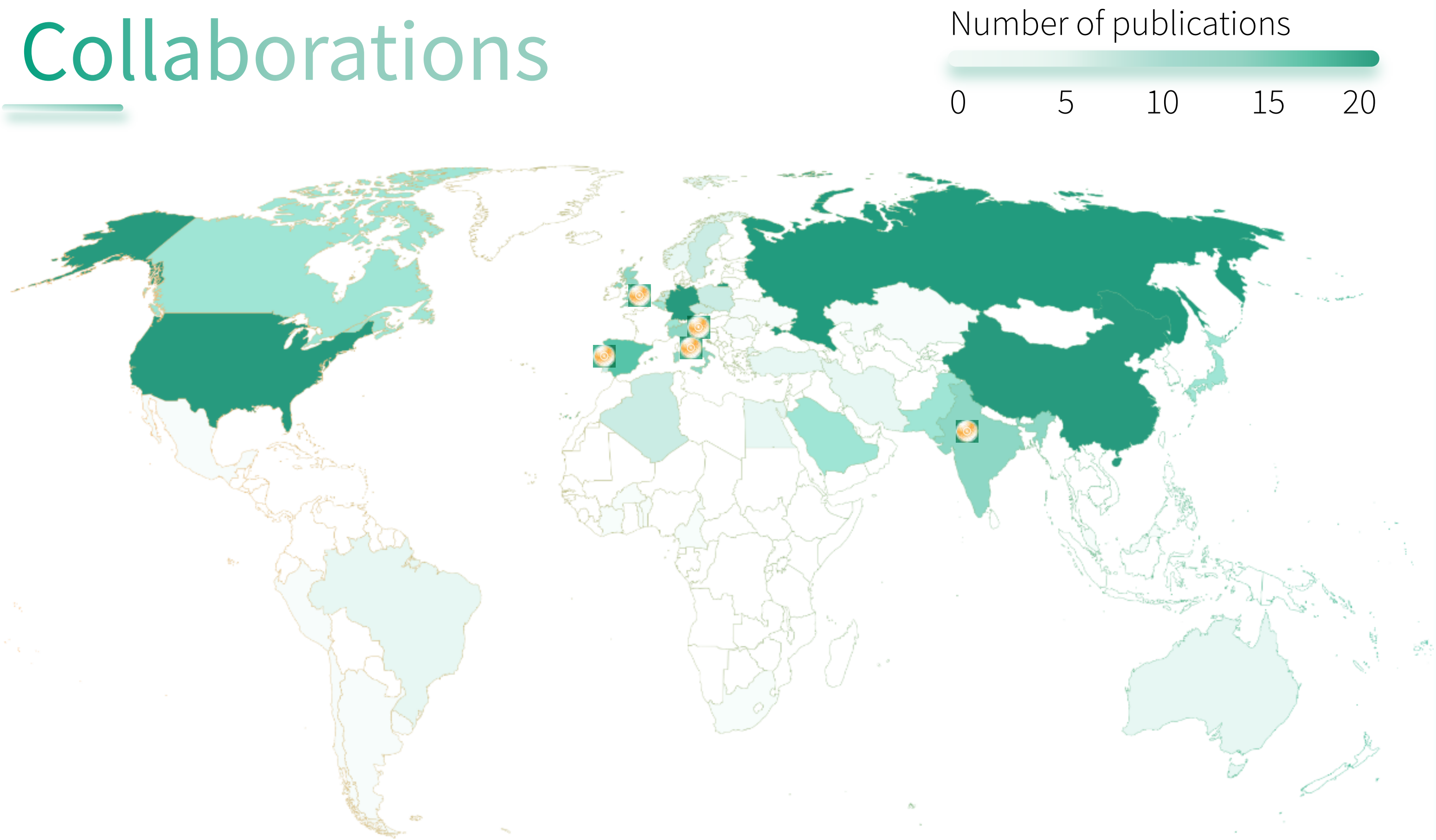
Writing Magnetic Information with a Single Ultra-Short Light Pulse

Wei Zhang, Michel Hehn, Yi Peng, Jon Gorchon, Quentin Remy, Jun Xiao Lin, Julius Hohlfeld, Grégory Malinowski, Wei Sheng Zhao & Stéphane Mangin

Digital technologies are consuming an ever-growing share of global energy, largely due to data storage and processing. In this work, we demonstrate a new way to write and erase magnetic information in an ultrafast and reliable manner using a single laser pulse lasting only a few picoseconds. The system studied is a nanoscale magnetic structure known as a spin valve, made of ultrathin metallic layers. Unlike conventional approaches, where the final magnetic state depends on the initial one, we show fully deterministic behavior, where the final state is controlled solely by the laser energy. One laser energy level writes the information, while another erases it, independently of the previous state. This breakthrough is achieved without using gadolinium, a rare element, and works in highly stable magnetic materials. It opens promising perspectives for future ultrafast, energy-efficient optical magnetic memories and next-generation spintronic devices.



International Collaborations



15
invited professors per year

55%
publications with international partners

50
nationalities in IJL

5
joint laboratories

European Projects

The Institut Jean Lamour actively engages in international collaborations and European projects, fostering scientific exchange and innovation across borders.

Its researchers participate in EU-funded programs, joint networks, and global partnerships, addressing challenges in materials science, energy, and sustainability.

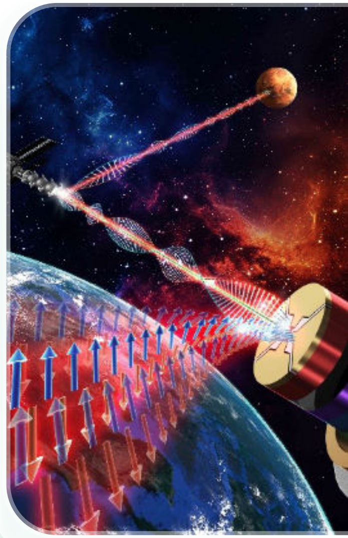
By combining multidisciplinary expertise with state-of-the-art facilities, the laboratory advances fundamental knowledge and delivers solutions with societal and industrial impact, strengthening Europe's scientific excellence and global research visibility.

Focus on Pathfinder Project

The rapid expansion of global data traffic demands a disruptive leap in high-bandwidth, energy-efficient communication technologies. At the same time, the acceleration of human activity in space makes reliable space communication indispensable. Laser-based space-light links are increasingly attractive for inter-satellite and ground-to-satellite communication. However, long-distance signal loss highlights the need for new, robust light-coding methods. It is unclear whether conventional lasers can meet future bandwidth demands for Earth and space communications while keeping power consumption low.

Recently, our team *("Nanomaterials for Optoelectronics group")* has demonstrated electrical control of magnetic information and its direct conversion into polarized light, as reported in *Nature 627, 783 (2024)*. This breakthrough opens a path to fundamentally new optical-telecommunication schemes. Building on this result, the Pathfinder SpinDataCom project aims to transform Earth-and-space data transfer by merging spintronics with semiconductor lasers injected with unequal spin-up and spin-down electrons.

This spin imbalance transfers to the circular polarization of emitted light, enabling ultrafast polarization modulation, low-power operation, and highly efficient information encoding, even at the single-photon level. The approach is compatible with existing fiber-optic infrastructure and can surpass conventional transmitters in speed and energy efficiency.



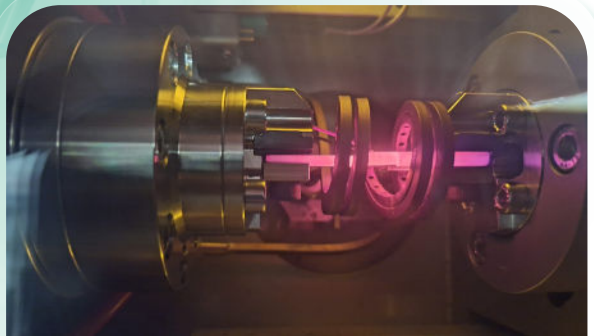
Uniting experts across four EU countries, SpinDataCom will deliver a TRL4 proof-of-concept spin-laser platform with full electrical spin and magnetization control. This disruptive technology has the potential to greatly impact society, the economy, and the environment through widespread terrestrial and space applications.

Priority Research Programs

PEPR, Priority Research Programs, are large-scale, strategically funded research initiatives launched by the French government to address major scientific, technological, and societal challenges.

PEPR programs aim to strengthen national and European research capacities, foster collaboration between public laboratories, universities, and industry, and accelerate innovation in priority fields such as energy, health, environment, digital technologies, and advanced materials.

They often involve multidisciplinary and multi-institutional consortia. The Institut Jean Lamour is involved in **29 projects of PEPR programs** (Spin, Diadem, TASE, SPLEEN, Hydrogen, SupraFusion, Sous-Sol, Recyclage, Batteries…)



Focus on DIADEM

Within the DIADEM program, the targeted DIAMS project aims to establish infrastructures enabling the accelerated design of metallic alloys for structural applications, to develop a methodology for deploying these platforms for and opened to the entire French metallurgy community, and to demonstrate their capabilities through three demonstrator projects carried out in partnership with the project stakeholders.

The *"Microstructures and Stresses"* team has developed and implemented this year the **IT2M platform — In situ Thermo-Mechanical characterization for Metallurgy** based at the ESRF in Grenoble, in collaboration with SIMAP. This high-throughput characterization platform brings together different thermomechanical simulators enabling in situ testing using High-Energy X-ray Diffraction (HEXRD) and Small-Angle X-ray Scattering (SAXS), thus providing key micro- and nano-structural information on an alloy’s constituent phases, their defects, their stress states and their respective chemistries, with time resolution (up to 500 Hz) during processing. The outstanding acquisition speed and spectrum quality are made possible by the use of next-generation detectors and the high brilliance of the beamline.

These new capabilities have enabled the development of a combinatorial metallurgy methodology—i.e., working with composition-gradient samples *("High-throughput compositional mapping of phase transformation kinetics in low-alloy steel")* or under controlled thermal-gradient conditions *("Microstructure optimization by combinatorial approach applied to Duplex Medium Manganese steels")* and thus exploring design spaces in an accelerated manner, compared to traditional approaches.

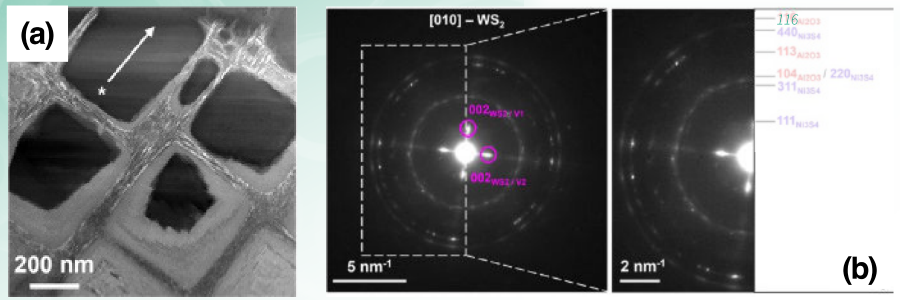
The new plasto-dilatometer installed in 2025 also makes it possible, for example, to simulate rapid or even extreme thermal cycles, as well as complex thermomechanical cycles frequently encountered in industry.

Industrial Collaborations

The Institut Jean Lamour offers a wide range of collaboration opportunities with industry, leveraging state-of-the-art facilities, multidisciplinary expertise, and flexible partnership models. Companies can engage through joint R&D projects, technology transfer, access to advanced instrumentation, and tailored consulting.

Dedicated industrial liaison teams support project design, confidentiality, and long-term partnerships, ensuring efficient integration of industrial challenges into cutting-edge materials research.

These collaborations drive innovation, accelerate technology development, and create practical solutions for diverse sectors.



(a) Bright field STEM micrograph of the oxidation front of DS200+Hf after 100 h of exposure at 600°C in air + 400 ppm SO_2 and (b) corroded γ/γ' microstructure: selected area electron diffraction (SAED) pattern and indexation of SAED.

Focus on Sustainable Materials

Improving the sustainability, reliability, and performance of technological components is an ongoing challenge aiming at minimizing energy and raw material consumption. The research group *Surfaces and Interfaces: Chemical Reactivity of Materials* has established long-term partnerships with major industrial groups (aerospace, foundries, chemicals) in order to contribute to the improvement of current technical materials by reducing their degradation in operating environments. Metallic and ceramic resistant materials and surface treatments are currently being developed as part of collaborative projects.

Innovative and controlled processes, as well as a thorough understanding of the chemical mechanisms operating at different scales, sometimes down to the atomic level, are essential for defining the most appropriate material solutions. For this, the group and the IJL's core facilities propose numerous testing facilities, from lab scale to semi industrial scale, allowing development and maturation of the materials and processes in various extreme conditions: from aqueous media to high temperatures in aggressive chemical environments (molten phases, gases). These include, but are not limited to, thermal analysis, heat treatment, room-temperature and high-temperature electrochemistry, and thermodynamic simulation.

In 2025, the research group has obtained four industrial doctoral grants, funding for three PhD and one postdoctoral position through IRT EPIC. Joint articles have been published, and joint patents have been filed. Furthermore, these partnerships give opportunities of industrial R&D carriers to PhD students.

Research Equipment

The Institut Jean Lamour hosts a truly unique and comprehensive equipment park dedicated to the elaboration of thin films and bulk materials, as well as to their advanced characterization.

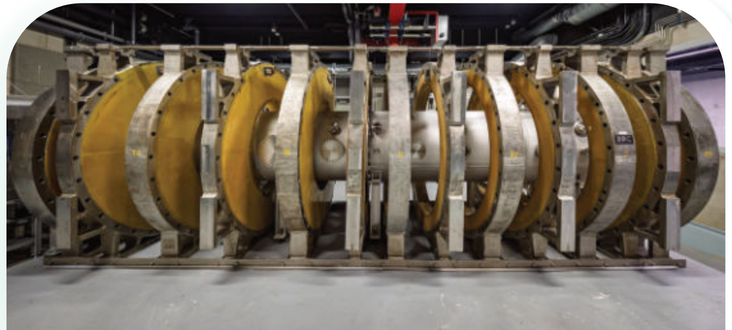
These state-of-the-art facilities enable precise determination of chemical composition, detailed analysis of crystallographic structures and microstructures, and thorough evaluation of functional properties, including optical, electrical, magnetic and mechanical behaviors... The strong complementarity of these instruments provides an integrated approach to materials research, from processing to performance.

All facilities are open and accessible within the framework of academic and industrial collaborative projects.

Focus on SPEKTRE

For the SPEKTRE machine team, **2025 will remain the year of the first plasma, obtained on April 4th** (see photo). This first plasma mainly served to validate the proper functioning of the machine's basic systems: vacuum circuit and helicon plasma source. The equipment was officially inaugurated **on September 22nd** in the presence of elected officials and representatives from the **University of Lorraine** and the **CNRS**. Scientific operation of the equipment is scheduled to begin in the first half of 2026. In the meantime, the SPEKTRE team is working on setting up the systems to produce the plasma confinement magnetic field and designing the first diagnostics instruments that will equip the machine.

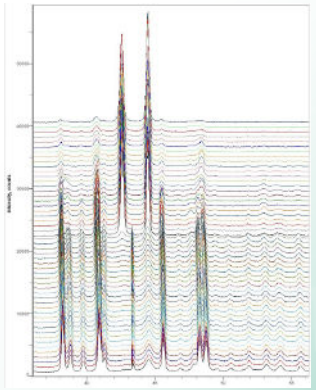
The initial studies will focus on two themes that have benefited from the launch of **2 ANR contracts** in 2025: the PRC TURBUPLAS project, resulting from a collaboration between IJL's *Fusion Plasmas* and *Plasmas - Processes - Surfaces* groups and the IRFM (CEA Cadarache), aims to characterise magnetized plasma turbulence and to test innovative turbulence control devices based in particular on Artificial Intelligence; the ANR POREDGE project aims to develop a new type of wall for future nuclear fusion reactors, based on the use of liquid metals in 3D-printed refractory metals, drawing on the expertise of IJL's *Materials and Additive Processes* team, and in collaboration with LEMTA and IRFM.



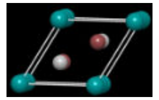
Core Facilities

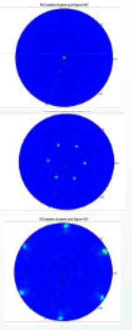
The Institut Jean Lamour hosts 8 core facilities, serving as centers of excellence in thin film growth, structural and microstructural characterization, micro and nanofabrication, scientific computation and surface analysis.

These core facilities provide open access to advanced equipment and expert support, fostering collaborations with both academic partners and the socio-economic sector. By enabling joint projects, training, and technology transfer, they bridge fundamental research and industrial applications, promoting innovation, knowledge exchange, and the development of solutions with societal and technological impact. Each of the 8 core facilities of IJL is committed to a quality assurance process led by the University of Lorraine.

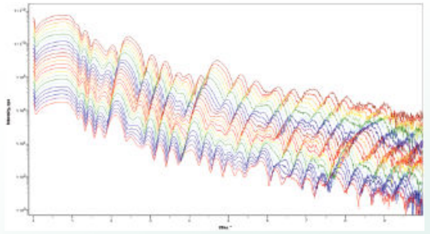


Focus on XGamma





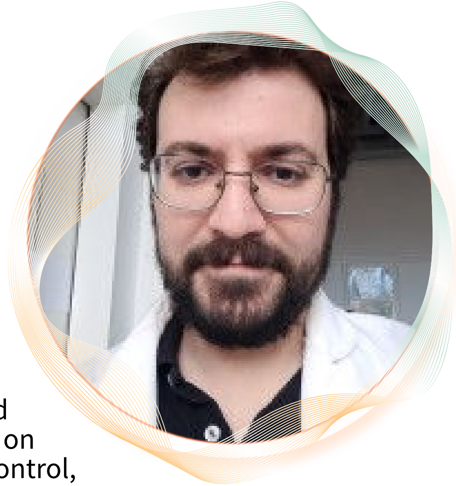
The XGamma platform is devoted to develop material characterization technics such as diffusion, diffraction fluorescence and tomography using X-ray and Mössbauer spectroscopy. It is in charge of 9 diffractometers (XRD), one fluorescence spectrometer (WDXRF), 2 X-ray tomographs and 2 Mössbauer spectrometers for all kind of materials (powder, single crystal, thin film and bulk materials). Recently 2 new diffractometers from Rigaku were installed to increase our competences for powder and thin film characterizations. Both diffractometers are equipped with a 9 kW Cu rotating anode. One diffractometer called "high & low temperature" is specially devoted to perform XRD versus temperature from 12 to 1773 K and the detector XSPA 400 ER, working in 0D, 1D or 2D, allows to precisely discriminate the diffracted beam around the Cu energy. The second diffractometer is a 5-circles diffractometer (ω, 2θ, χ, φ, θχ), with an Hypix 3 000 detector also working in 0D, 1D or 2D. This diffractometer can be equipped with 2 monochromators Ge(220) and Ge(400), one large XY sample holder allowing to perform XRD mapping measurements using beams size down to 50 µm.



The figure shows typical measurements recently performed with these two diffractometers: on the upper level, figures represent pole figures measurements on hexagonal unit oriented along (001) showing a single domain with the six folds symmetry shown at 42° for the (102) direction and at 90° for the (110) direction. On the right hand side reflectometry measurements (XRR) performed using a mapping setting ((beam size of 50 µm)) along a wedge every 2mm along the 6 cm long sample. On the left hand side, XRD temperature measurement from 20 to 340K showing a high entropy alloy orthohexagonal polymorphic transition.

New Hires
Interviews

Isnaldi Rodrigues De Souza Filho
Junior Professor at CNRS



Can you tell us about your background before joining IJL?

Before joining the Institut Jean Lamour as a CNRS Junior Professor and Chair in Sustainable Metallurgy, my career developed across leading research institutions focused on materials science and low-carbon metallurgical processes. After completing my PhD at the University of São Paulo, awarded the national prize for the best doctoral thesis in Engineering, I moved to the Max Planck Institute in Düsseldorf – Germany, first as a postdoctoral researcher and later as an Alexander von Humboldt Fellow. In 2021, I became Group Leader of the Sustainable Synthesis of Materials group at the Max-Planck Institute for Sustainable Materials, coordinating research, supervising young scientists, and building international collaborations. There, I contributed to pioneering projects on hydrogen-based reduction of iron ores, plasma-assisted processes, impurity control, and circular metallurgical strategies. This work included *our Nature publication "Green steel from red mud through climate-neutral hydrogen plasma reduction (2024). Nature, 625, 703-709"*, demonstrating that industrial waste from aluminum production can be transformed into CO_2-free iron through hydrogen plasma, opening a new pathway for circular and sustainable steelmaking.

What led you to choose this career path?

My motivation to pursue this career comes from a long-standing interest in understanding how microstructure, thermodynamics, and processing govern material performance. Early academic recognition strengthened my commitment to research, while international experience exposed me to the scientific and societal relevance of developing cleaner metallurgical technologies. Over time, it became clear to me that materials science plays a central role in enabling the global energy transition.

Why did you choose to work on the topic of sustainable metallurgy?

I chose sustainable metallurgy because it addresses one of today's most urgent challenges: drastically reducing CO_2 emissions from metal production. Steelmaking alone accounts for a significant share of global emissions, and new processes based on hydrogen and plasma offer a transformative pathway. Working on solutions that combine scientific depth, technological innovation, and environmental impact strongly aligns with my goals as a researcher and with my mission at IJL/CNRS. This vision also extends beyond ironmaking, as shown in our recent Nature publication "Sustainable nickel enabled by hydrogen-based reduction (2025). Nature, 641, 365–373 ", demonstrating that critical metals such as nickel can also be produced through carbon-free hydrogen routes, supporting the broader decarbonization of materials essential for the energy transition.

Xiaocui Wu
Researcher at CNRS

Can you tell us about your background before joining IJL?

IJL offers an excellent scientific environment, strong interdisciplinary collaborations and state-of-the-art experimental platforms. The institute's research strengths align very well with my background and long-term scientific goals, making it an ideal place to grow my work and contribute to a dynamic research community.

What led you to choose this career path?

My research focuses on developing innovative methods for controlled deposition of molecular species from solution into UHV environment. Combined with scanning probe microscopy, this approach allows to characterize molecular stacking, structural defects and charge transport applied to organic photovoltaics, with ultimate goal to advance the design of next-generation polymer-based solar technologies.

Gwladys Steciuk
Research engineer at CNRS

What has stood out to you the most since you arrived at the institute?

I've had the chance to be warmly welcomed at the IJL and to work with a wonderful team at the *Microscopies, Microprobes and Metallography Core Facility (CC3M)*. It's often said that you need to step back to get a broader view; however, from our basement at the CC3M, we're actually in contact with a large part of the IJL teams and involved in a wide range of research projects. The diversity of the topics studied and the availability of numerous cutting-edge instruments create a scientific dynamism that isn't found everywhere.

Could you briefly describe your work on the microscopy platform?

My main role is to support research by performing TEM characterizations.
I see each sample and each project as an investigation to solve. TEM is like a big Swiss Army knife, almost "infinitely" adaptable, and it provides pieces of a much larger puzzle. It's a fascinating job that constantly pushes me to develop new skills and leaves no room for monotony.

Awards

3 members of IJL have been appointed to the IUF *(Institut Universitaire de France)* for a five-year term as part of the 2025 campaign : Halima Alem Marchand, Michel Hehn & Mourad Oudich.

In addition, Stéphane Mangin has been elected **a member of the European Academy of Sciences.**

Halima Alem-Marchand

Professor in the Nanomaterials and Health team, as a senior member (Innovation Chair)

Michel Hehn

Professor in the Spintronics and Nanomagnetism team, as a senior member (Innovation Chair)

Mourad Oudich

Associate Professor in the Metamaterials and Phononics team, as a junior member of the IUF.

Stéphane Mangin

Professor in the Spintronics and Nanomagnetism team, and an internationally recognized specialist in magnetism and spintronics

Start-Ups Creation

S.A.M

SIGNATURE & AUTHENTIFICATION DES MATÉRIAUX

→ S.A.M is a French Tech start-up based in Nancy, founded in 2022, after six years of university research in the fields of materials science and computer science. ←

The start-up was co-founded by Samuel Kenzari (head of the *Materials and Additive Processes group* at IJL) and Sylvain Lefebvre (head of the MFX project team, a joint unit of Inria, the CNRS, and the University of Lorraine under the auspices of the Loria laboratory). The start-up S.A.M has developed an innovative product for certification and anti-counterfeiting, in addition to designing a new approach to information storage. This phygital (physical-digital) innovation is classified as "deep tech" and protected by seven families of patents and software developments in materials science and digital technologies (CNRS – INRIA – University of Lorraine).

This unique technology is a solution for securing physical and digital assets. It allows data to be stored directly in the printed material itself. It is offline, low-tech, and sovereign.
The SAM solution is based on a token, a physical object 3D printed with an anti-counterfeiting coding material. This material has a non-reproducible internal signature capable of being authenticated using X-ray diffraction (XRD) analysis. What sets it apart is that it contains a unique crystallographic signature that cannot be broken down. Thus, the printed token is physically authenticable, signed, and unique (non-copyable) despite being 3D printed. Its non-reproducibility secures any objects against unauthorized duplication. The data is encoded directly into the token during its 3D printing process and can be recovered using the dedicated reader. This ensures integrated traceability and recovery of information without a database or digital link.

- **Deployment modes:**
Certificates, communicating seals, and hardware access keys

- **Markets:**
Industry, luxury, healthcare, defense, security, critical infrastructure

www.signaturesam.com

The technology relies on an app, a material reader and a 3D-printed token.
Video demonstration of S.A.M Technology: *click here*

3D-printed Tokens using Fused Filament Fabrication with S.A.M Coding Material.

Open Science

HAL open science

Open Plasma Science

The Institut Jean Lamour is strongly committed to an ambitious and transparent open-science policy. All research articles published since 2013 by the laboratory have been systematically referenced on the HAL open archive. This represents more than **4 090 publications**, with more than **2 400 providing full-text open access**, ensuring broad dissemination of the laboratory's scientific output. According to its own Open Science Barometer, **89% of the Institut Jean Lamour publications in 2024 were available in open access**, reflecting a sustained effort toward openness. Each of the laboratory's 24 research groups manages a dedicated HAL collection, enabling the tracking of indicators while offering direct access to their most recent publications. These collections also provide complete publication lists accessible from each team's webpage, strengthening visibility. The institute also promotes the use of unique researcher identifiers to support reliable attribution and interoperability across systems.

As of today, **97% of researchers and faculty members at Institut Jean Lamour hold a ORCID identifier (and 96% an IdHAL)**. Finally, the Institut Jean Lamour is firmly engaged in the progressive opening of its research data, reinforcing its commitment to a more accessible, collaborative, and sustainable scientific ecosystem.

Click/Scan the following QR Code to accees *IJL's HAL Collection* :

Open Plasma Science has been founded in 2024 by Jérôme Moritz, Research Director at CNRS at the Institut Jean Lamour, in collaboration with the Open Science service of the Université de Lorraine and the CCSD of the CNRS, in order to fill a gap in the plasma research landscape.

Plasma science is divided into communities – fusion plasmas, cold laboratory plasmas, and natural plasmas – each publishing in separate journals, with no venue allowing results to be shared openly across all fields. Most existing journals rely on hybrid or gold open access models, where authors must pay high APCs, **often exceeding 1 000 to 2 000€**, which represents a barrier for young researchers or teams with limited funding. Institutions also discourage paying APCs for subscription-based journals, while embargo policies may conflict with funders' requirements for immediate open deposit. To address these limitations, a Diamond Open Access model has been chosen for Open Plasma Science: free for authors and free for readers.

The journal operates under a single-blind peer review process to ensure scientific quality while maintaining openness and supporting the free circulation of knowledge. The journal is hosted on the Episciences platform, supported by the CNRS, ensuring transparency and long-term stability. It relies on open repositories such as HAL and arXiv for dissemination and archiving, fully aligned with the FAIR principles (Findable, Accessible, Interoperable, Reusable).

Greenano

GREENANO

→ The GreenNano Master's program trains 25 of the best international talents in the field of sustainable nanotechnologies each year, selected from more than 500 applications from 17 countries. ←

Funded with €5 million by the European Union through Erasmus Mundus, this excellence program brings together the Institut Jean Lamour, the Faculty of Science and Technology and the École des Mines of the University of Lorraine, as well as the University of Tor Vergata in Rome, the Italian CNR, and the Jožef Stefan Institute in Slovenia.

Students follow a unique curriculum: one semester in France, one in Italy, one in Slovenia, and a final semester dedicated to an internship. Their training covers physics, materials science, and advanced fabrication processes, such as plasma techniques. Special emphasis is placed on sustainability: critical metals, substitution strategies, carbon-based materials, and environmental impact analysis.

GreenNano aims to train 100 experts capable of supporting Europe's technological transition. Many go on to internships or PhD positions at the Institut Jean Lamour, contributing to scientific dynamism and strengthening ties with partner companies.

French Science Festival

→ **On October 3 and 4, 2025, the Institut Jean Lamour hosted the Science Festival.** ←

The event highlighted research on materials and offered the public an insight into the many activities carried out within the institute. The first day was dedicated to welcoming high-school classes, while the second was open to the general public.

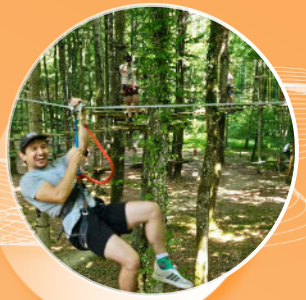
The program included interactive workshops, several lectures given by researchers on a variety of topics (energy, health, nanomaterials, micro/nano fabrication, fusion, big data), as well as tours of major scientific facilities.

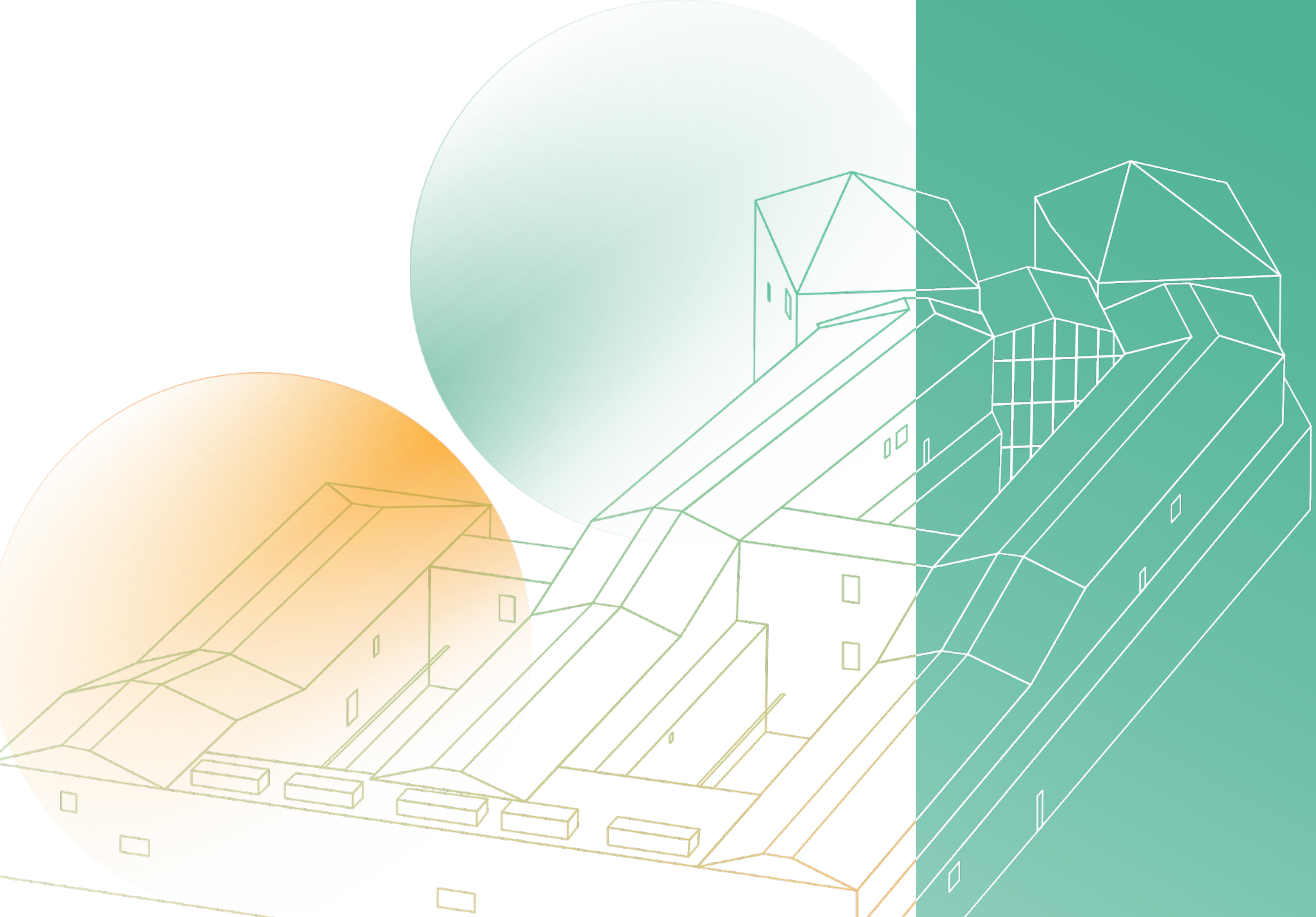
In total, the event brought together **400 participants**, eager to learn more about the science shaping the world of tomorrow.

Life In the lab

IJL cultivates a warm and supportive atmosphere by organizing a variety of events throughout the year. These moments, whether large or small, help bring people together, encourage collaboration, and strengthen the sense of community. Through these ongoing initiatives, the lab maintains a positive environment where everyone can feel included and engaged.

Moreover, **Le Cénacle**, an association created by PhD students, helps ease the arrival of newcomers through meetings, culture-sharing activities and social events that strengthen the sense of community within the lab.





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