LMOPS – UR 4423

LABORATOIRE MATÉRIAUX OPTIQUES PHOTONIQUE & SYSTÈMES

The LMOPS laboratory is composed of 23 faculty members, among which 17 permanent researchers from Lorraine university and 5 from CentraleSupélec, along with 13 PhD students and 2 post-doctoral staff. The laboratory is mainly situated on the Metz Technopole campus, and has two local branches in Thionville-Yutz and Saint-Avold.

OPTICAL MATERIALS, PHOTONICS & SYSTEM

LMOPS is divided in three research groups, respectively devoted to Functional Materials, Photonics and Photovoltaics. It also has a running chair program (Chair in Photonics) and two experimental platforms respectively dedicated to spectroscopy and electrical measurements.

LMOPS also actively participates to the PIA2 IDEX / I-SITE *Lorraine Université d'Excellence* (LUE) project promoted by Lorraine university. The goals of the LUE initiative are to develop the international leadership of the Lorraine site, on engineering viewed from a systemic perspective around major economic and societal challenges.

FUNCTIONAL MATERIALS TEAM

The activities of the Materials team are organized in three major themes : the growing of bulk materials for non linear optics and the study of fire behavior and fire-proofing of polymer materials (*nanocomposite polymers* theme). The bulk material theme is focused on the study of growth and characterization of new materials that are more effective and more resistant allowing the realization of VUV sources (λ<300nm) of high power and stable in the time. For this, two experimental methods are available in the laboratory: the "micro-pulling down" technique (μPD). Concerning the fire retardant research, a booming research topic is the study of flame retardancy of continuous fiber thermoplastic composites. This subject is directly related to the needs of the socio-economic environment of the East-Moselle. The influence of aging on the fire performance of these complexes flame retardant polymer systems is also studied.

Concerning the growth of new photovoltaic materials, the team acquired in 2018 a new spray-pyrolysis equipment (funded by CentraleSupélec) allowing a rapid return of the results of characterizations and modelizations on the growth and structure of the layers and cells. Moreover, the team is also studying photovoltaic cells and modules from other laboratories for specific properties such as aging, effects of thermal and electrical stresses, properties of certain layers (eg transparent conductive layers, absorbent layers) as a function of doping, growth conditions of the gap profile, etc.

PHOTONICS TEAM

The Photonics research team's main theme is nonlinear optics, a domain which is studied using several distinct approaches. Optically induced waveguides and the experimental link they allow between optics and quantum physics using the analogy between optical and quantum behavior equations are studied to provide efficient experimental ways to investigate otherwise unreachable quantum behaviors. Spatio-temporal nonlinear dynamics are also investigated as they lead to an intriguing self-organization property of light itself. The temporal side of these dynamics leads to chaos that could be used for ultra-efficient all optical encryption. Finally, optical neuro-inspired computing based on reservoir computing is a new topic that is rapidly gaining importance in the team. Hybrid, as well as all-optical approaches are investigated for various prediction or recognition tasks. The team has today gained an unchallenged international recognition with paper published in prestigious journals and has a running chair program on photonics with unprecedented funding from both the public and private partners of the laboratory.

Also some researchers have an expertise in spectroscopy to study disturbances and order breaks in various materials (crystals, polymers, solutions) through Raman signatures related to point or extended defects, doping,

phase or phase transformations, domains, components of a mixture, crystallites, etc, but also to perform metrology and control of complex environments by attempting to establish a link between the characteristics of the Raman line (position, width, intensity) and a physical parameter: strain, electrical field, temperature, concentration, size, etc. One of the important topics is the correlation with other techniques (X-Rays measurements, dielectrics, optics) and the coupling with Raman measurement (DSC/Raman, WAXS or SAXS/Raman, Rheology/Raman).

SYSTEMS TEAM

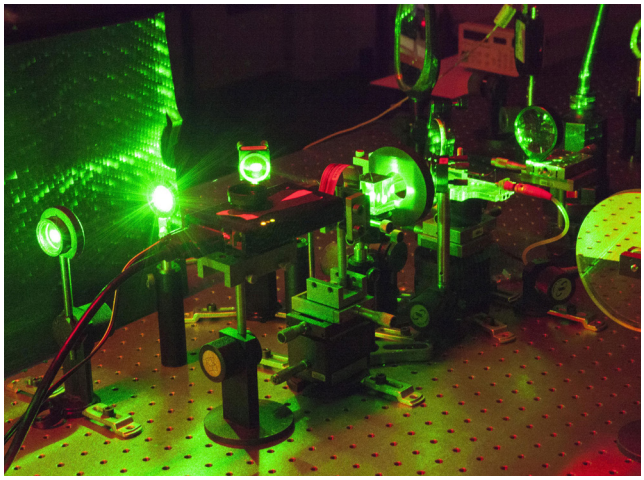
The Systems team main theme concerns the optimization of the various parts of energy production systems starting upstream by the development and modeling of the efficiency of photovoltaic modules – converters – generators – structures. The activities are devoted to photovoltaic systems, which is its mainstream research, but also to more general renewable energy sources. The activities are based on important know-how bringing together various specialties and skills of the different members of the team namely: physics, materials, electronics, optics and systems.

HIGHLIGHTS 2023

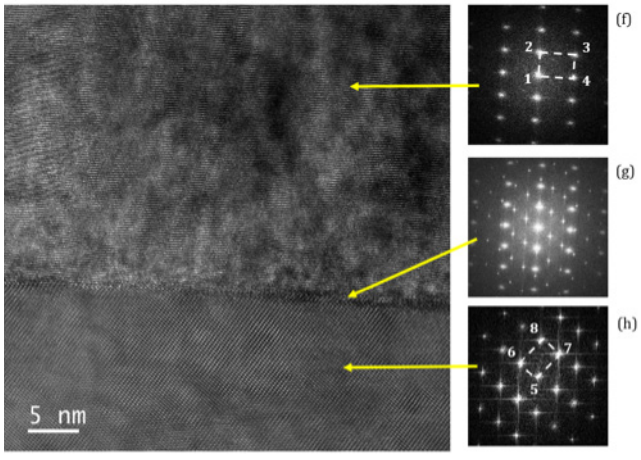
THE INTERNATIONAL SYMPOSIUM ON PHYSICS AND APPLICATIONS OF LASER DYNAMICS 2023 (IS-PALD 2023) took place in Metz from November 19 to 21, 2023. It has been an opportunity to learn advances in physics and applications of laser dynamics through invited talks by renowned scholars and through contributed presentations, both oral and poster, by active researchers. All types of conventional and emerging lasers are covered, such as semiconductor, solid state, fiber, quantum well, quantum dot, quantum cascade, and ring cavity. Meanwhile, the Symposium creates an environment for extensive discussion and potential collaboration with researchers worldwide. Two areas of laser dynamics are covered in the Symposium: Ultrafast Laser Dynamics et Nonlinear Laser Dynamics.

EXAMPLES OF STUDIES

Research team ***Materials***



Research team ***Photonics***



Research team ***Systems***

Industrial Partners

- AIRBUS,
- ArcelorMittal,
- ARKEMA,
- Cristal Laser,
- EDF,
- GDI Simulations,
- Institut de Soudure,
- M-Optics,
- Pôle Matéralia,
- SAFRAN,
- SHASTA CRYSTALS,
- TOTAL.

Academic Partners

Institut Jean Lamour (IJL), Laboratoire d'Etude des Microstructures et de la Mécanique des Matériaux (LEM3), Laboratoire de Chimie et Physique - Approche Multi-échelle des Milieux Complexes (LCP-A2MC), Laboratoire de Cristallographie, Résonance Magnétique et Modélisations (CRM2), UMI2958 Georgia-Tech-CNRS, Institut Lafayette, Laboratoire de Nanotechnologies et d'Instrumentation Optique (LNIO), Université du Luxembourg, Ecole des Mines d'Alès, Luxembourg Institute of Science and Technology, Universités de Bruxelles, Institute for Color Science and Technology (Tehran, Iran). Université de Padoue (Italie), Osbnabrück, Institute for Physical Research (Yerevan, Arménie), Université de l'Oural (Russie), Université de Tlemcen (Algérie), ICube, Laboratoire Charles Coulomb, Laboratoire de Physique des Lasers, Institut des Nanotechnologies de Lyon...

Key figures

• Professors, Associate Professors & Researchers	23
• Engineers & Administrative staff	8
• PhD Students	13
• PostDocs	2
• Visiting Professors	2
• Publications of the year (WoS)	52

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