Namur Institute of Structured Matter (NISM)

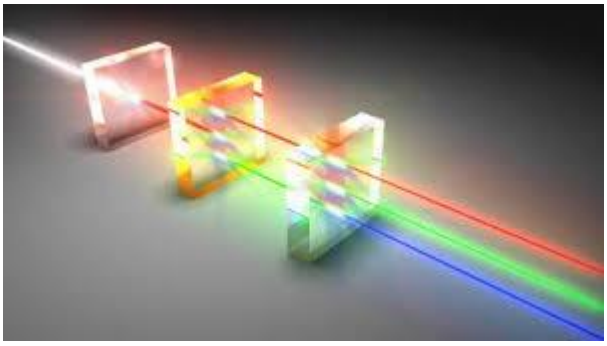
The researches of the **Namur Institute of Structured Matter** cover various topics in the field of **organic and physical chemistry**, **biophysics**, **material and surface sciences, solid-state chemistry and physics,** from both a **theoretical** and an **experimental** point of view.

NISM researches investigate the structured matter from 0 to 3 dimensions, with the purpose of unveiling its fundamental properties as well as in view of its technological applications. An important role is played by theoretical approaches, through numerical simulation and modelling, which contribute to the development of new molecular systems and materials, and to the prediction of their properties.

The applications involve a broad range of topics including among others photonics and biophotonics, nonlinear optics and molecular spectroscopies, (photo)catalysis, plasma physics and chemistry, thin inorganic and (bio-)organic films, functional coatings, nanomaterials …

1. Nonlinear Optics and Photonics

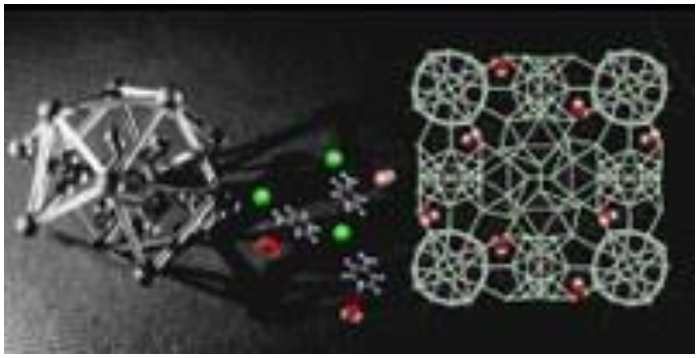
Research is carried out in nonlinear optics (NLO), quantum NLO, plasmonics, and photonics, applied to multiscale structured matter (i.e. molecules, surfaces, biomaterials, nanomaterials, metamaterials, and crystals). Optical responses and their coupling to vibrational and electronic excitations are predicted, from theoretical models using numerical simulations, and measured, using dedicated experimental setups, with the goal to better understand light-matter interactions in natural or in artificial systems, and to optimize their effects in view of technological applications.



2. High Performance Computing (HPC) Multiscale Modelling

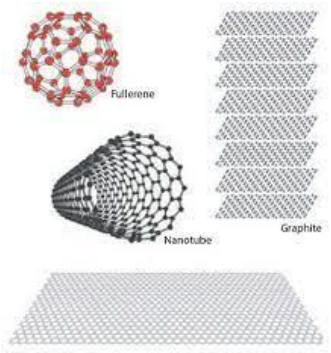
The HPC pole aims at 1) sharing computational techniques, skills and tools in order to develop new materials and predict their final properties as well as 2) improving the modelling techniques and computer codes to account for most of the chemistry and physics of structured matter.

3. Functional Structured Materials



The core of our expertise is divided in two interconnected areas: 1) the development of 3D porous architectures including hierarchical organizations, MOF or MOF-like systems, biologic, organic/inorganic hybrids both using silica and carbon-based media, nanocomposites… 2) the functionalization of nanostructures such as carbon nanotubes, fullerenes (C_{60}), pillar-arenes, silsesquioxanes (POSS)...
The applications cover various hot topics including: Li-batteries, CO_2 conversion, biomass conversion, photosynthesis, (photo)catalysis, inhibition of viral and/or bacterial pathogens, biomaterials, sensors…

4. Surfaces, Interfaces and Carbon Nanostructures



This pole is active in synthesis, characterization and modelling of novel materials, with particular attention to interfaces between two distinct phases and to low-dimensional structures including carbon nanostructures (graphene, nanotubes). A large choice of deposition and characterization methods is available within the SIAM and Morph-Im technology platforms.

A strong theoretical support is provided to understand 2D-material synthesis and growth, and to interpret experimental data.

STRONG POINTS

- **Tight collaboration between experts in organic and physical chemistry, material chemistry, biophysics and (bio-)photonics, nonlinear optics, surface and solid-state sciences**
- **Strong expertise in both theoretical and experimental approaches to investigate structured matter**
- **Development of new advanced methods for the synthesis and the study of structured matter**

Development of **0D, 1D, 2D and 3D** inorganic and organic/inorganic materials with selective functionalization and applications.

Understanding and prediction of fundamental properties of structured matter

Applications in photonics and biophotonics, nonlinear optics and molecular spectroscopies, (photo)catalysis, plasma physics and chemistry, thin inorganic and (bio-)organic films, functional coatings, nanomaterials …

Molecular → supramolecular → nanoscale → microscopic level

Research and development of **outstanding characterization techniques (experimental and theoretical approaches)** including X-ray photoelectron spectroscopy, ion spectrometries, solid-state nuclear magnetic resonance, vibrational and rotational spectroscopies, linear and nonlinear optical spectroscopies, multi-scale modelling and simulations ….

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