Alliance 7: Nanosensors and Nanomaterials for Healthcare and Biology

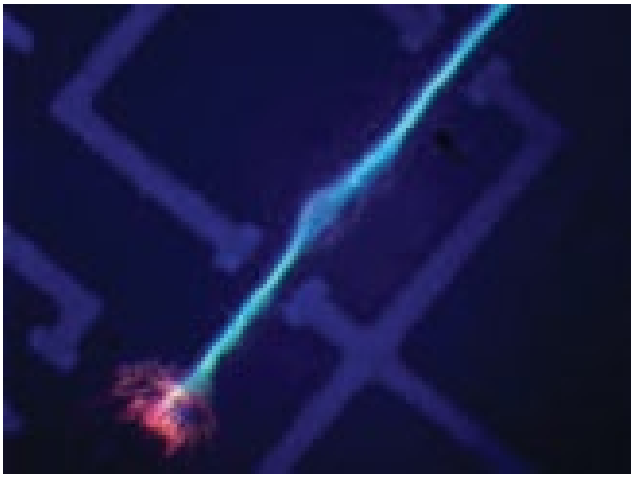
Research axes and facilities

Physicists and chemists of INAC and of NEEL, in collaboration with G2Elab, have established expertise in different areas required for the development of innovative tools for biology and healthcare. Expertise in the field of materials science for biology and medicine includes the development of diamond layers, magnetic and semiconductor nanoparticles and arrays of high performance micro-magnets. These objects are functionalized by either chemical or electrochemical processes. High sensitivity detection of biological reactions or recognition processes is being realized using microliter calorimetric cells, electrochemical sensors, Scanning Electrochemical Microscopy, surface plasmon resonance with nanoparticle amplification and novel fluorophores. Sample manipulation, a key step in biosensing, is being optimized at the microscale through the trapping of biological objects by micro-magnets, the guided growth of neurons on micro-patterned substrates or the laser induced actuation of nano-objects. The alliance's strongly interdisciplinary projects, associating biologists and physicians, address important biological questions and major health issues. This research is upstream in the development of biotechnologies for miniaturized tests, lab-on-chip devices and ultrasensitive diagnostics.

Actions within LANEF

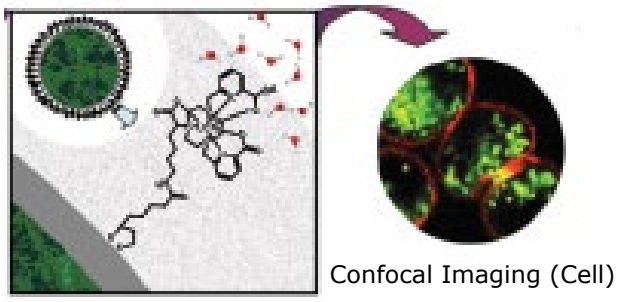
Magnetic micro- and nano-objects. Micro-and nanoparticles of various types and appropriately functionalized are being developed for use in magneto-mechanical actuation, e.g. cell manipulation and destruction, drug delivery, micro-surgery… Arrays of micro-magnets are being developed for the attraction or repulsion (diamagnetic levitation) of biological species (e.g. cells). Such arrays are being integrated into micro-fluidic systems incorporating electrodes / coils for dielectrophoretic / magnetophoretic manipulation of cells in lab-on-chip applications.

Novel concepts for biochips. Functionalization of nanostructures and nanoobjects such as optical guides or torques is being used to produce novel supports for parallelized, miniaturized assays. Patterned surfaces are being optimized to control growth and displacement of cells. Emphasis is placed on guided neuron growth above field effect nano-transistors. More complex devices will be designed such as artificial tongues, cell chips and bacterial detectors. Theoretical work should unravel recognition between biomolecules.



Neuron growth on a silicon structure to record electrical activity at the sub-cellular level (with Grenoble Institute of Neuroscience)

New developments in fluorescence detection. Major efforts are being made to design new fluorophores with increased stability and quantum yield, improved biocompatibility and tunable working wavelength range. Organic nanocrystals, inorganic quantum dots and metal complexes are being designed and synthesized. Novel chemistry will be exploited to couple these probes to nanoparticles and biomolecules for major applications in imaging and biochips.



Fluorescent labeling of cells using functionalized quantum dots

Scanning electrochemical microscopy. Scanning electrochemical microscopy (SECM) with nanoscale resolution is being developed, through the use of nanoelectrodes, for functionalizing nanoparticles and to prepare the sensing part of biosensors. Moreover, SECM will be used as an effector for local modifications.

Miniaturized calorimetric biosensors. New methods are being developed for the detection of small energy exchanges involved in biological and biochemical processes. Titration systems allowing the measurement of nanowatts, based on microfluidics on self-sustained membranes, are being developed. This study strongly benefits from existing know-how in grafting specific enzymes or biomolecules on surfaces.

Key figures: **30 Permanent scientists from INAC, NEEL, G2ELab**
30 PhD students and postdocs
Strong collaborations IEMN (Lille); Laboratoire Ampere (Lyon), Institut Curie (Paris), Grenoble Institute of Neuroscience & CLINATEC (Grenoble)

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