LABORATOIRE DE CHIMIE ENS DE LYON

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New light sources and microlasers from hybrid colloidal building blocks

Nouvelles sources lumineuses et micro-lasers à partir de colloïdes hybrides

Synthesis of original **hybrid colloidal nanoparticles** will be explored –combining **photoactive molecules** and **dielectric scatterers and/or plasmonic nanostructures**– as well as their **assembly** for designing **innovative light micro-sources**.

Miniature photonic integrated devices, in optoelectronic, biomedical or catalytic applications, involve the development of new local light sources. In this context, light sources based on scattering media for amplified spontaneous emission (ASE) or random lasing (RL) are considered to be one of the most promising alternatives to conventional lasers or thermal sources. Composed of scattering and gain materials, these systems present numerous benefits: (ultra)small size, inexpensive and easy to fabricate, low spatial coherence, tunable and with a unique response. Regarding this wealth, a multitude of works have been recently emerging to investigate the physical phenomena, especially in systems such as: suspensions of dyes and particles, active nanopowders or doped polymers.

In the PhD project we propose to go further by controlling both the synthesis of emitting building blocks (gain+scatterer) and their assembly in disordered materials. As example, silica nanoparticles doped with luminescent lanthanide complexes, associated with silver or gold nanostructures, could be a promising starting system. Self-assembling behavior and optical properties of such hybrid nanoparticles will be investigated aiming for preparation of new light sources and integration in future photonic devices.

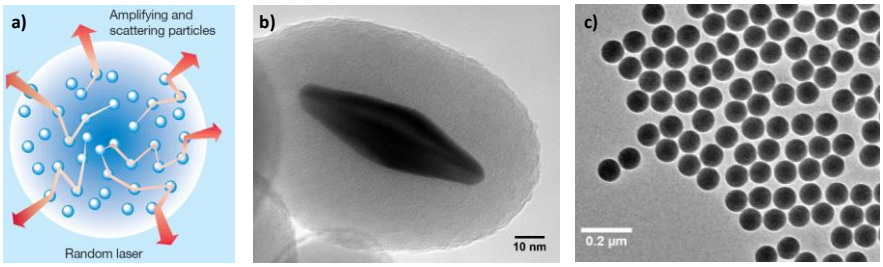

Figure - a) Schema of a random laser from ref 1. Transmission Electron Microscopy images of -b) gold bipyramid encapsulated in SiO_2 and -c). Tb(III) complexes doped SiO_2 nanoparticles.

- Multidisciplinary collaboration in the research group: (nano)materials chemists (A. Désert, S. Parola, B. Abécassis), molecular chemists (C. Andraud's team) and photophysicists (P. Baldeck, N. Lascoux).
- Local and international collaborations (Physic Laboratory of ENS, ILM Lyon, Wroclaw University, University of Liege, etc) for the optical properties, the design of microreactors and microfluidic systems, and the study of photoinduced reactions.

- Sol-gel process & *chimie douce* - Synthesis, surface modification and assembly of hybrid nanoparticles
- Spectroscopy (UV-vis absorption, fluorescence) - electron microscopy (SEM, TEM) - scattering techniques (DLS, SAXS, GISAXS)

- Good experimenter with knowledge in materials chemistry and physical chemistry of materials.
- Curious, comfortable with bibliography resources and motivated by working with several researchers in a multidisciplinary team.

1- D. Wiersma, "Laser Physics: The Smallest Random Laser." *Nature*, 406, 6792, 132, 2000
2- R. Carminati, P. Sebbah. "Les lasers aléatoires." *Photoniques*, 70, 34, 2014
3- P. Sebbah, R. Carminati. "Breakthroughs in Photonics 2014: Random Lasers." *IEEE Photonics Journal*, 7, 1, 2015