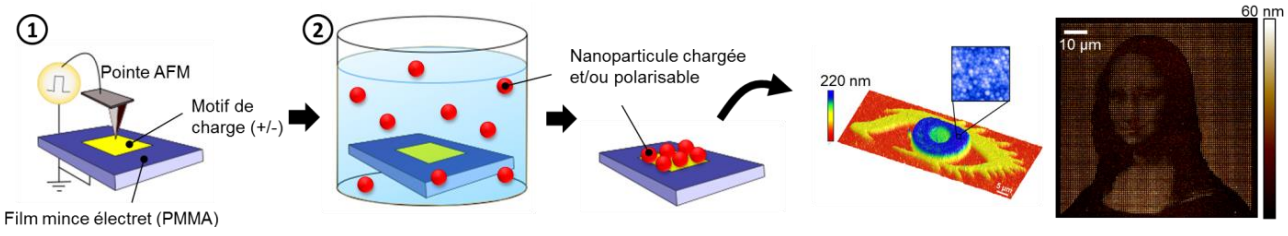
Microfluidic tools for the study and the assembly by nanoxerography of colloidal nanoparticles

Laboratoire de Physique et Chimie des Nano-Objets (LPCNO-UMR 5215 INSA-CNRS-UPS) @ Toulouse, Fr

- Experimental and multidisciplinary project
- Job available asap. 12 month contract funded by ANR (could be renewed)

KEY WORDS: Directed assembly, Nanoxerography, Colloidal Nano-objects, Microfluidic, Plasmonic, Hydrogel

Introduction and context – The study of the original properties of colloidal nanoparticles synthesized by chemical means and their integration to realize the active area of functional devices require their directed assembly on specific areas of solid or flexible surfaces. Since few years, the *Nanotech* team of the Laboratory of Physics and Chemistry of Nano-Objects (LPCNO- UMR 5215 INSA-CNRS-UPS) at Toulouse, Fr has developed an innovative technique called nanoxerography, which can tackle this challenge. This process consists in injecting, in an electret material, via an AFM (Atomic Force Microscopy) tip, electrostatic charges. The obtained charged patterns are then used as trapping sites to assemble electrostatically on the surface, charged or polarized nano-objects initially dispersed in solution (*cf.* figure below). It is also possible, during the charging step, to address surfaces of tens of cm² using soft lithography based methods which are also mastered in the team.



Scheme describing the two step process of the AFM nanoxerography technique: (1) Electrostatic charge injection (2) Development in a colloidal dispersion - Two examples of 3D assemblies of 22nm $NaYF_4$ nanoparticles realized by AFM nanoxerography are presented on the right part of the figure

During two previous PhD studies, the *Nanotech* team has demonstrated that assemblies of controlled density [1], of single or binary particles (with two types of nanoparticles) [2] could be fabricated in 2D and even in 3D with certain kinds of systems [3]. The main novelty of this project is to realize the second development step of the process, labelled (2) in the previous scheme, not anymore within a beaker containing a colloidal dispersion but in a microfluidic cell.

Subject – The proposed work is mainly structured around two research axes:

(i) **Optimization of a microfluidic set up for the in-situ observation of nanoparticle assemblies onto a charged substrate.** The *Nanotech* team is recently equipped with brand new microfluidic tools in partnership with the company Fluigent. This has led to the buildup of a first experimental set up which still requires numerous improvements: optics, camera, microfluidic cell, automatization, etc. that the candidate will have to deal with. Once the new set up optimized, it will help the real time observation for a more in depth characterization of the kinetics of the nanoparticle assemblies. In particular, it will allow the quantification of the adhesion forces after assembly between nanoparticles and substrate.

(ii) **Original assemblies and applications**. The *Nanotech* team has demonstrated that the nanoxerography technique is a generic directed deposition method which permits the assembly of a large range of nano-objects of interest onto localized areas of a rigid/flexible substrate. The idea is to take advantages of the microfluidic tools and their assets to obtain new types of assemblies and nanoparticle based applications.

We propose several approaches that the candidate will lead:

1/ Multi-assemblies. Combining the properties of various types of nanoparticles assembled together on specific areas of a substrate may for instance reveal or enhance plasmonic phenomena. The assembly realized inside a microfluidic cell will allow adding or deleting quickly a monolayer of one certain type of nanoparticles and so will help studying its effect over the optical response of the global assembly.

2/ « From synthesis to assembly » on a chip. The team has very recently studied the assembly of hydrogel nanoparticles synthesized by nanoemulsion and grafted by nanoxerography. In the following of this study, the goal would be to create a new technique of microfluidic based synthesis of nanogels that could be assembled right after by nanoxerography, all integrated on the same microfluidic chip.

3/ Oriented and directed assembly. With the aim of benefiting from the properties of anisotropic nanoparticles for sensor based applications, the candidate will investigate the capability of using the directionality of a solution flow in a microfluidic channel to realize the assembly of nano-objects on substrates not only on a very defined zone but with a controlled orientation.

Required Profile – Engineer or Doctor in the nanoscience domain. A specialty/expertise in the field of directed assembly of nano-objects or microfluidics will be appreciated.
The postdoc candidate will be integrated in the *Nanotech* team of the LPCNO in Toulouse, Fr where he will be trained in the use of microfluidic equipments, characterization techniques of nanoparticle assemblies along with the micro/nanostructuration processes associated with the nanoxerography method. The postdoc candidate must be appealed by experimental work which will occur most of the time in the new clean room of the team. He has to be dynamic, demonstrate scientific curiosity and rigor to complete successfully the project and might be led to supervise a PhD student from the team working on related topics.

Contact – Interested in this offer? Please feel free to contact Prof. Laurence Ressier and Dr. Etienne Palleau
laurence.ressier@insa-toulouse.fr / epalleau@insa-toulouse.fr - tél : +33 05.61.55.96.72

References - [1] Ressier et al, *IEEE T Nanotechnology*, 8, (2009); [2] Palleau *et al*, *ACS Nano*, 5, (2011) ; [3] Sangeetha *et al*, *Nanoscale*, 5, (2013)