Subject proposal for Master 2 internship

Title:
"**Anisotropic magnetic composite polymers dedicated to cancer cell sorting function in microfluidic systems**".

Supervisor/Contact:
Anne-laure Deman: Anne-laure.deman@univ-lyon1.fr or 04 72 43 14 37
Damien Le Roy: Damien.le-roy@univ-lyon1.fr or 04 72 44 80 46

Laboratory and location:
The internship will take place at Institut des Nanotechnologies de Lyon, in the Microfluidic & Microsystems group and at Institut Lumière Matière in the Magnetic Nanostructures group, both located at Léon Brillouin building – UCBL campus (Villeurbanne)

Key word:
Composite polymer, Magnetism, Magnetic Nanoparticles, Self-assembling, Microfluidic systems, Circulating tumor cell

Context:
 Circulating tumor cells (CTCs) are cells that have escaped from a primary tumor site and are circulating into the body via blood vessels. CTCs thus constitute seed for the subsequent growth of additional tumors (metastasis) in other organs. Collecting CTCs can serve to characterize their metastatic behavior and their resistance to different treatment.
However, owing to the extremely low abundance of CTCs (one CTC in millions of blood cells), detection and characterization of CTCs remain a challenging task. Microfluidic systems are promising tools for CTC trapping, in particular via the implementation of magnetic functions[1,2]. Indeed, magnetic functions allow a contactless manipulation of cells, does not require cumbersome equipment and permit high selectivity through anti-gene / anti-body recognition.
In this context, composite polymers, based on polydimethylsiloxane (PDMS) matrix doped with magnetic nanoparticles, offer great advantages for the development of low cost and high performance magnetic microfluidic systems. Indeed, the integration of magnetic flux micro-sources becomes rather simple as it only involves soft-lithography techniques and surface activated bonding. In addition, the control of the organization of magnetic particles within the polymer matrix permits to confer anisotropic magnetic properties to the composite and to develop novel trapping and sorting functions. Recently, INL and ILM has developed magnetic functions based on anisotropic magnetic Iron-PDMS composite [3].

This intership is part of a research program in collaboration with Hospices Civils de Lyon.

Objectives:
First objectives are to create composite polymers with high aspect ratio magnetic nanostructures and high magnetization, such as chains of FeC nanoparticles, in order to reach optimized magnetic properties in the

specific context of CTC trapping. It is proposed to explore different means to control the composite microstructure, including applying non-uniform magnetic field during the fabrication[3].

Then, the developed composites will be implemented in microfluidic devices, and the work will consist in assessing the magnetic performances in view to achieve a high recovery rate of CTCs from biological sample.

During the internship, the student will realize composite polymers and characterize their magnetic properties using a Superconducting QUantum Interferences Device (SQUID) magnetometer at the "Centre de Magnétométrie de Lyon" (CML). We expect to achieve a better understanding of the involved mechanisms that set the microstructure and its correlation with the magnetic properties.

The student will realize microfluidic system integrating composite micro-patterns. Microstructuration of the composites will be done using lithography techniques at Nanolyon Platform of INL. Microsystems efficiency will be assessed via the implementation of trapping or separation functions of paramagnetic micro-beads in micro-channels. Characterization of biological samples will be realized in collaboration with Hospices Civils de Lyon.

The intern will benefit from the CML platform and to the microfluidic facilities provided by INL (Nanolyon Platform, 50m² clean room) and gain training in various areas including: magnetic characterization, polymer composite realization, micro-fabrication in cleanroom environment, video-microscopy and data analysis, biological sample manipulation.

Potentiality for a PhD work as a follow-up : Yes – Funding already obtained
Nature of the financial support : Région AURA program

Références:
[1] P.Chen et al. Lab Chip (2014, 14, 446
[2] T. Y. Lee, Sensors and Actuators B, (2017), http://dx.doi.org/doi:10.1016/j.snb.2016.05.163
[3] AL Deman et al. Microfluid. Nanofluid. (2017) 21 :170

Lyon 1