INSTITUT NÉEL Grenoble

Topic for Master 2 internship – Academic year 2023-2024

Magnetic manipulation of nanoparticles in a microfluidic chip

General Scope :

Magnetic nanoparticles are commonly used in biomedical applications such as magnetic resonance imaging (MRI), magnetic particle imaging (MPI), drug delivery, diagnosis, but also to manipulate biological entities such as cells, proteins, DNA … The displacement of magnetic nanoparticles under an external magnetic field, also called magnetophoresis, requires magnetic field gradients, which should be especially high as the size of the particles decreases. To manipulate particles in the 10-nm range, the required magnetic field gradients can only be produced by micromagnets that have a very short range of action. Therefore, controlling magnetically the motion of magnetic nanoparticle requires the development and integration of micrometric magnets inside microfluidic channels where the magnetic landscape can be designed precisely. Furthermore, such devices can be advantageously used to selectively act on magnetic nanoparticles in order to separate them and refine their distribution.

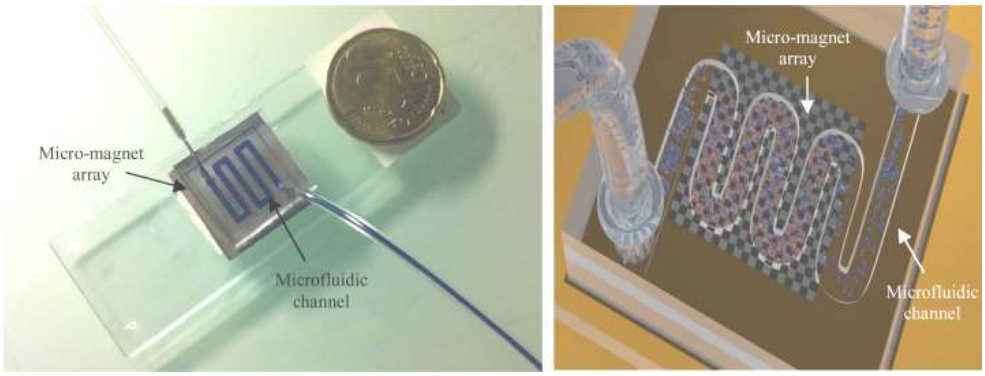

Figure 1: examples of a microfluidic chips with embedded micromagnets: (left) photograph, (right) a schematic of magnetic cell sorting (Pivetal et al, Sensors and Actuators B- Chemical, 2014 , https://doi.org/10.1016/j.snb.2014.01.004)

Research topic and facilities available :

This internship aims at exploiting magnetic forces at the microscale for purification and separation of magnetic nanoparticles. Micromagnets will be designed and produced with methods established in Institut Néel (topographic patterning, thick film deposition, thermomagnetic patterning and regular lithography processes). Magnetically hard materials (permanent magnets), soft magnets (that can be remotely turned “on” and “off”) in combination with a variable external magnetic field will be used to induce trapping, release, trajectory deflection and ultimately separation of magnetic nanoparticles according to their magnetic moment, susceptibility and volume. Micromagnets will be integrated into polymer-based microfluidics systems to manipulate the trajectories of magnetic particles in microfluidic channels. This new degree of control combined with established tools such as chromatography or electrophoresis will allow for the development of a new generation of systems for analytical chemistry.

Possible collaboration and networking : The internship and the following PhD are part of a funded project in collaboration with Institut Galien (Paris-Saclay) and Phenix Lab (Sorbonne University, Paris)

Possible extension as a PhD : Yes

Required skills: Background in material sciences, physics, or soft matter is required with a taste for experimental physics

Expected start of internship: Early 2024

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