Research Topic for the ParisTech/CSC PhD Program

Subfield: Physics, Hydrodynamics, Complex fluids, Microfluidics

ParisTech School: ESPCI ParisTech

Title: Fluid-structure interaction in microfluidic flows

Advisor(s):

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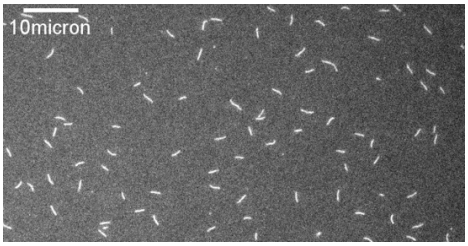
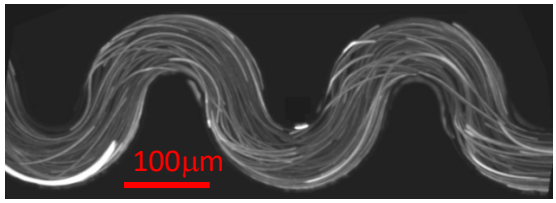
Short description of possible research topics for a PhD:

Complex fluids are ubiquitous in nature and industrial applications. In biology, saliva or blood are well-known examples of such fluids. Their non-Newtonian character is due to microscopic objects suspended in simple fluids. Under flow these objects are oriented, rearranged or deformed leading to a macroscopic response of the material. Precisely measuring this macroscopic response is not always possible using classical rheometers due to their limited resolution. Microfluidic rheometers using specific geometries can circumvent these limitations.



Model suspension of actin filaments (Image Yanan Liu, PMMH-ESPCI)



A novel microrheometer to acces normal stress differences (Josephine Zilz, PMMH-ESPCI).

Here we propose to build upon the knowledge gained in our group over the last years to study a model biofluid made of actin filaments in different microfluidic rheometers as for example the serpentine channel shown on the figure above.
Direct observations of the microscopic dynamics of the actin filaments under flow will reveal the nature of the fluid-structure interactions determining the filament deformation and transport. These microscopic interactions will be linked to the macroscopic suspension properties to establish a direct link.
The fundamental understanding gained in the PhD project will lead to a better understanding of the properties of real biofluids as well as the design of suspensions of specific properties, that could for example be used as replacement fluids for blood plasma.

Required background of the student: Physics, if possible Hydrodynamics, Complex fluids or Soft Matter

2-3 representative publications of the group:

1. Li et al (2018) *Morphological transitions of elastic filaments in shear flow.* PNAS 115 (38) 9438.
2. A. Lindner, *Flow of complex suspensions*, Phys. Fluids 26 101307 (2014)
3. A. Lindner and P. E. Arratia, *Special Topic: Invited Articles on Microfluidic Rheology,* Biomicrofluidics 10 (4), 2016