IMT Nord Europe
École Mines-Télécom
IMT-Université de Lille

M2 Internship

Fluorescent rotors for probing shear-stress in micro-scale flows

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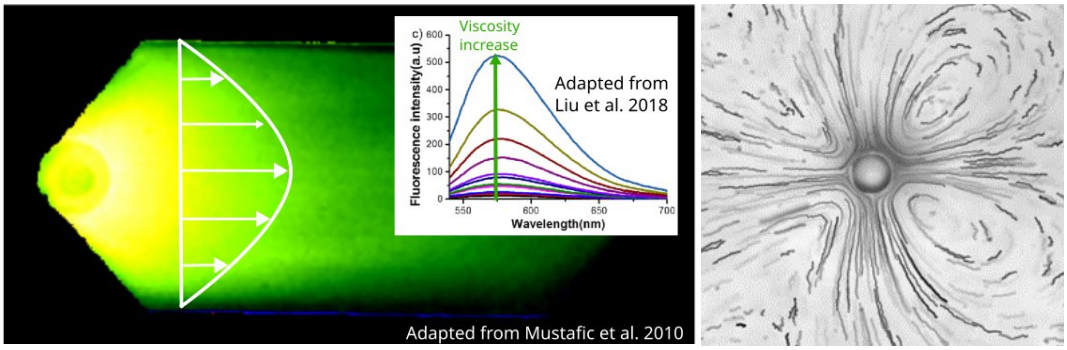
Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Context: Complex flows of complex fluids at micro-scales are frequently encountered in industrial, environmental, and even health applications. In that context, shear-stresses can (i) play an important role in the development of the flow field, in particular for non-Newtonian fluids and complex channel geometries, and (ii) be exploited in applications in the biological field [1]. Unfortunately, there is still a lack of experimental methods available to directly measure shear-stress in flows. Experimentally, shear-stresses are mostly derived from the fluid velocity field measured by high resolution three-dimension three-component measurements, which is quite expensive and challenging to implement. A promising alternative could be a fluorescence-based methods, using well chosen dyes whose luminescence depends on the shear-stress or viscosity (analog to laser induced florescence methods used to measure concentration, temperature or pH fields).



Left : Visualisation of shear-stress with fluorescent rotors ; Right : Flow visualized in a simple acoustofluidic system.

Objectives and tasks: The aim of the internship is to demonstrate the feasibility of a method employing fluorescent rotors to measure local shear-stress and/or viscosity in micro-scale flows [2],[3]. Once validated, the method will be used for shear-stress measurement in an acoustofluidic device (with potential application in cell manipulation) [1]. The project will involve the following tasks

- **Literature review** on previous studies on fluorescent rotors and dyes employed
- **Fabrication** of fluid samples, micro-channels
- Benchmark **experiments on a straight micro-channel flow**
- Experiments on a **straight micro-channel flow with complex fluids**
- Experiments in **an acoustofluidic device** with simple fluids
- **Data processing** and presentation

Profile of the candidate: We are looking for an enthusiastic and motivated Engineering/MSc/M2 student, with solid basis in physics and/or fluid mechanics and taste for cutting edge experimental and fundamental research. Strong analytical, organization and communication skills, and proficiency in English language are required. Programming skills (Matlab or Python) and priori experience with microfluidics are also highly desirable. Additionally, basic knowledge in optics, optical methods for fluid mechanics, acoustics and/or image processing would be a plus.

Work environment: The project will be partly carried out at the research centre of **IMT Nord Europe** in Douai, **center for energy and environment,** and partly at **IEMN laboratory,** in Villeneuve-d'Ascq, on a rhythm to be discussed and agreed on with the selected candidate. The internship is partially funded by the **ANR project IFrOG.** The starting date is between January and March 2024 and the duration 4 to 6 month.

How to apply: Send detailed CV, cover letter and transcripts to **Tom LACASSAGNE** tom.lacassagne@imt-nord-europe.fr **and Sarah CLEVE** sarah.cleve@univ-lille.fr – **Applications will be considered until the position is filled.**

[1] J. Wu (2007). « Shear stress in cells generated by ultrasound. » *Progress in biophysics and molecular biology* , vol. 93, n°1-3, p.363-373. doi: 10.1016/j.pbiomolbio.2006.07.016

[2] A. Mustafic, H.-M. Huang, E. A. Theodorakis, et M. A. Haidekker (2010). « Imaging of Flow Patterns with Fluorescent Molecular Rotors », *J Fluoresc*, vol. 20, n° 5, p. 1087‖1098. doi: 10.1007/s10895-010-0661-x.

[3] F. Liu, Y. Luo, et M. Xu (2018). « Viscosity measurements using a two-photon ratiometric fluorescent sensor with two rotors », *Tetrahedron Lett.*, vol. 59, n° 52, p. 4540‖4544. doi: 10.1016/j.tetlet.2018.11.009.