Dynamics of fibers transported in confined viscous flow

Jean Cappello[1], Marine Daïeff[1], Camille Duprat[2], Olivia Du Roure[1] & Anke Lindner[1]

[1] Physique et Mécanique des Milieux Hétérogènes, CNRS UMR 7636, ESPCI Paris, Université Paris Diderot, Paris, France
[2] LadHyX, CNRS UMR 7646, Ecole Polytechnique, Université Paris-Saclay, Palaiseau, France
jean.cappello@espci.fr

The transport and dynamics of elongated objects has been extensively studied in unbounded media such as the situation of sedimenting fibers in Stokes Flow. Here we focus our study on the dynamics of particles transported in pressure-driven flows in confined geometries (geometries where at least one of the dimensions is comparable to a typical dimension of the object). We show that the confinement tunes the friction forces on the fiber and as a consequence the velocity of the object becomes anisotropic for high confinement [1]. These passive hydrodynamic effects lead to complex transport dynamics of fibers : simple straight fibers drift while transported, L-shaped fibers first rotate until an equilibrium position due to there front-rear asymmetry and then drift and elastic fibers deform while transported. We chose to investigate these effects with a combination of well-controlled microfluidics experiments and simulations using modified Brinkmann equations [2].

We control shape, orientation, and mechanical properties of our particles using micro-fabrication techniques [3] and in-situ characterization methods [4]. Fibers are created using a photosensitive polymer that we crosslink using UV light that passes through a mask on which the geometry of the required object is drawn. Diluting the polymer with water or short polymer chains we modify the network of the gel and thus tune the Young's modulus of the fibers. As a consequence we obtain either rigid or flexible fibers that we can study under flow.

Références

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