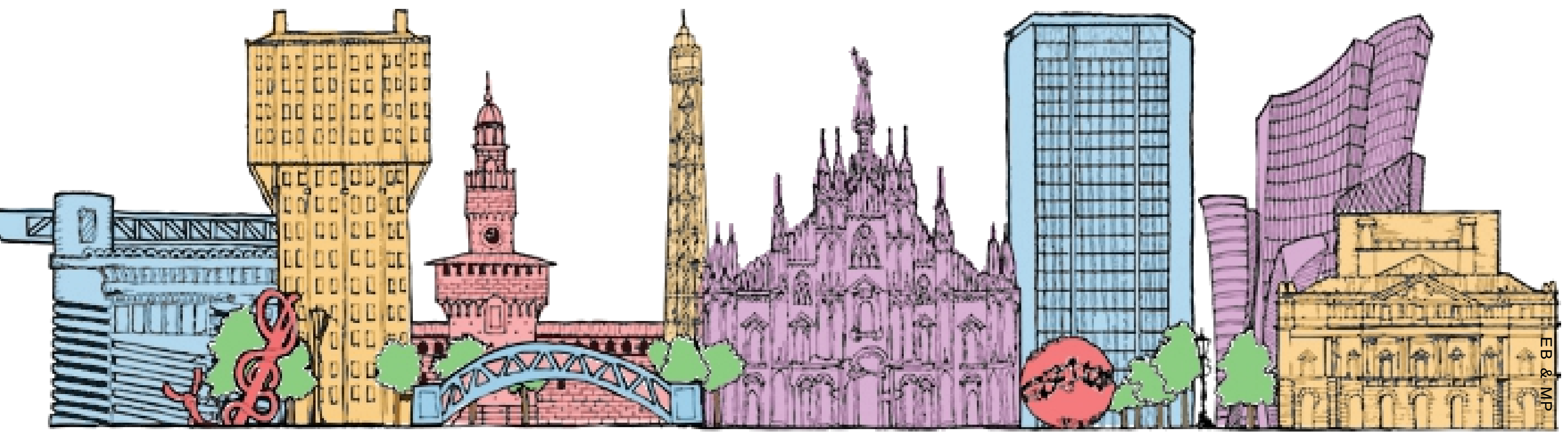
5th INTERNATIONAL CONFERENCE

MNF 2016

MICRO AND NANO FLOWS

BOOK OF ABSTRACTS



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Highly Deformable Hydrogel Nanofilaments in Poiseuille Flow

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The flow of deformable objects has non-Newtonian character, strongly influencing its short time response at microscopic level. Under the flow this objects are oriented, deformed and coiled leading to a microscopic variation of the transport properties. The microscopic structure as well as the microscopic response depends on both the nature of the suspended objects and geometry of the flow. Theoretical assumptions, especially in the field of polymer physics, use coarse-grained models to study the folding process of nucleic acids and proteins. However to describe this phenomenon on a molecular scale it is still limited to very small length and time scales. In these scales it is very difficult (or impossible) to find answers to basic questions about the potential effects of interactions or complex hydrodynamic behaviour of long biological molecules. Introduction of microscale model for elastic properties allow for precise optical measurements and the use of a simple hydrodynamic models that allow for the description of dynamic of elastic bio-objects such as DNA or protein [1-2]. Classical methods of analysing flow properties, based on general microscopic observations are not sufficient for generating quantitative data for the future modelling. In addition, it is very difficult to directly model of microbial processes that require complex molecular interactions. Migration of fibres or other long objects in Poiseuille flow is one of the fundamental problems of modern lab-on-chip thermodynamics Moreover, this is important in a variety of biological, medical and industrial contexts, such as Brownian dynamics of proteins, DNA or biological polymers, cell movement, movement of microbes or drugs delivery.

A comprehensive understanding of the dynamics of individual polymer objects is crucial for their further applications [3-4].

The present study is based on the idea that highly deformable polymeric nanofilaments, produced by electrospining technique, can easily travel in crowed environments of body fluids and biological tissues. Hydrogel nanofilaments, prepared by NIPAAm and cross-linker BIS-AAm in defined proportions, are placed in a microchannel, and then treated with a laminar flow. Geometry and dimension of nanofilaments (contour length from a few to several tens of microns and diameter around 100 nm) and mechanical properties (persistence length) are well-defined. Study of bending dynamic of nanofilaments moving in the flow is carried out using fluorescence microscope. Pulsatile flow, generated by precise micro pumps, causes the coiling and the uncoiling of the analyzed filaments. This procedure is designed to simulate intercellular flows. Study of this behavior can help to determine the impact that the conformational changes are periodic movements. In order to perform an in depth analysis the flow profile in the channel was determine.

The results are useful for the verification of the theoretical models of biological and physical phenomena responsible for the dynamics of the bending of long bio-objects (proteins, DNA). Furthermore, the obtained results help to understand the link between the microscopic structure of the very flexible nanofilaments and the macroscopic flow properties opening the possibility to design nano-objects transported by body fluids for targeted drug release or local tissue regeneration.

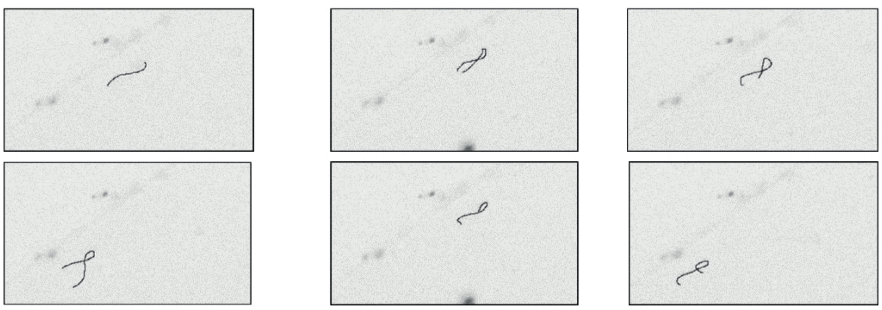

Fig.1. Sequence of image of a single flexible nanofilament (diameter 100 nm, contour length 25 μm) conveyed by Poiseuille flow.

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