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PROCESSING AND MECHANICAL PROPERTIES RELATIONSHIPS IN HYDROGEL NANOFILAMETS FOR BIOLOGICAL APPLICATIONS

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The increasing request of fast and efficient techniques for medical diagnosis and patient treatment is now challenging researchers to find new materials able to overcome the problems involved in the conventional clinical trials and cures. Over the last years, the interest in nanomaterials has increased significantly because of its wide range of applications in several technological, environmental and biomedical fields. A whole series of micro and nanosized materials have been synthesized in order to develop new techniques of diagnosis and therapy. Highly sensitive and selective biosensors based on nanomaterials have been fabricated in order to increase the performance and to minimise the invasiveness degree of the devices [1]. Controlled drug delivery systems are used to improve the conventional administration of drugs. The main challenge is to synthesize materials able to find a defined target and to release drugs in a spatially and temporally controlled manner avoiding drug overexposure or inefficient treatments [2]. Several research tasks have been focused on developing ideal drug delivery systems made by hydrogel due to their unique structural properties, nontoxicity and biocompatibility [3].

The present study is based on the idea that soft and flexible nanomaterials can easily travel in crowed environments of body fluids and biological tissues. Modification of their mechanical properties obtained by changing of the cross-linker amount may give us the possibility to tune the material rigidity according to desired application. Here, we describe a novel method based on coaxial electrospinning for obtaining highly flexible hydrogel nanofilaments able to transport and release dedicated molecules. Their typical length is from several um to over 1 mm, and the average diameter is of the order of 100 nm. Two different types of hydrogels (poly(N,N-isopropyl acrylamide) and polyacrylamide) with three polymer/cross-linker ratios were produced and deeply studied.

The nanofilaments morphology were characterized using scanning electron microscopy (SEM) and atomic force microscopy (AFM) and the release of bovine serum albumin (BSA) as a function of time was quantified. Mechanical properties of highly deformable hydrogel nanofilaments were evaluated by bending dynamics (persistence length) and Brownian motion observation techniques. The calculated mechanical properties were compared with data obtained by atomic force microscope nanoindention.

The results highlight the crucial role of morphology and stiffness on mobility of nanofilaments colloid systems. The information gained are fundamental to design nanoobjects with well-defined chemical and physical behaviour.

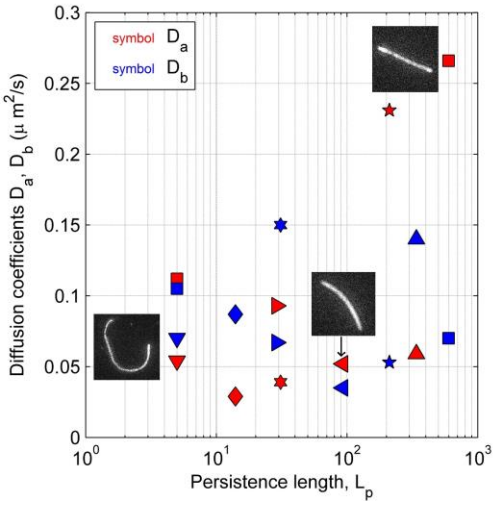

Figure 1. Nanofilaments diffusion coefficient (D_a and D_b) as function of persistence length.

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