Nanofiber formation using Pf1 virus and Cytochrome C.

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The production of electrostatic salt depend self assembled and induced assembled microscopically organized nanofibers is presented.

Here we report a novel method for the production of electrostatically aggregated nanofibers using Pf1 virus and cytochrome c. These types of nanofibers have countless applications ranging from quantum dot batteries to robust fiber production amongst others.

Pf1 is a bacteriophage that has a positively charged protein coat and exhibits a characteristic rod-shaped structure. These characteristics are similar to other viruses from the same family such as the fd and M13 viruses.

Cytochrome c is a negatively charged protein with physiological functions of electron transfer and apoptosis. The opposite charges of the virus and cytochrome c lead to a strong and spontaneous aggregation in solution.

Through the aggregation of Pf1 virus and cytochrome c, nanofibers with very particular properties were obtained. These nanofibers are electrostatically bonded, resulting in a strong fiber in aqueous solution which can be disrupted by the addition of monovalent salts above a certain critical salt concentration. The nanofibers can be either created by a mechanical process of alignment (confinement) or by a strong (>7 Tesla) magnetic field, enabling the construction of a macroscopic non-crystalline ensemble with well-defined molecular orientation of its components. The dialysis process can preserve the assembled structure.

Several methods have been used to evaluate and characterize the formed complex. Both liquid and dry state Atomic Force Microscopy (AFM) were used to evaluate its morphology, Raman, NMR, DOSY-NMR and DLS were used to characterize the system. Computational methods were able to elucidate the details of docking between virus and cytochrome (figure 3) as well as the overall thermodynamic tendency for aggregation by Monte Carlo simulations.

This work is suported by Fundação para a Ciência e Tecnologia PTDC/SAU/BMA/122444/2010, including grants to Rúben Chaves and Héber Silva.

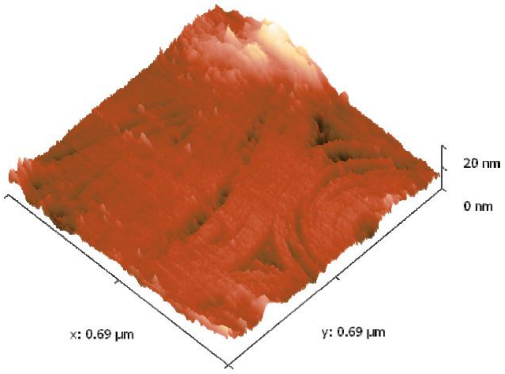

Figure 1. Liquid scanning AFM of assembly of the Pf1 virus with cytochrome c on a mica surface at low salt concentration.

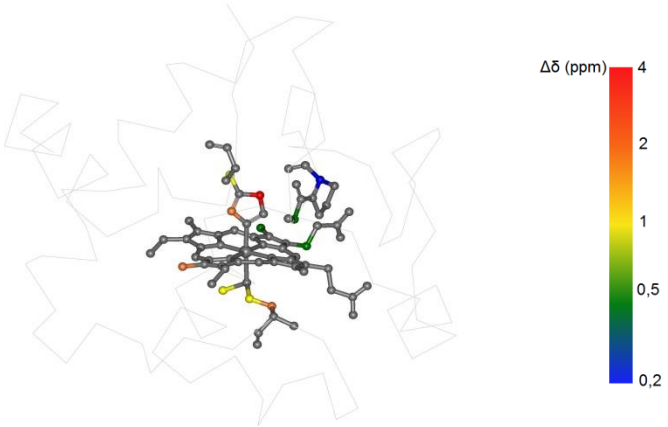

Figure 2. Representation of RMN chemical shift variation in cytochrome c upon binding with Pf1 virus induced by low ionic strength.

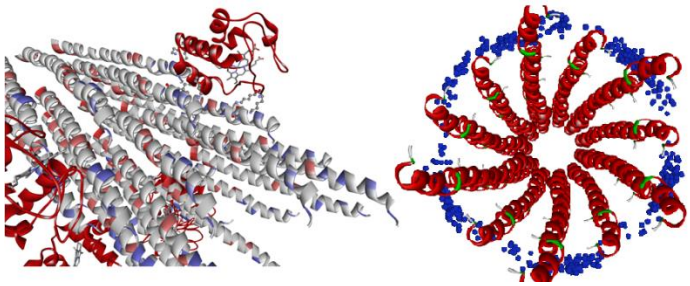

Figure 3. Computational docking results between Pf1 virus and cytochrome c Rigth most favourable comformations in ribbon plot. Left center of mass of cytochrome (blue dots) around Pf1 virus in red.

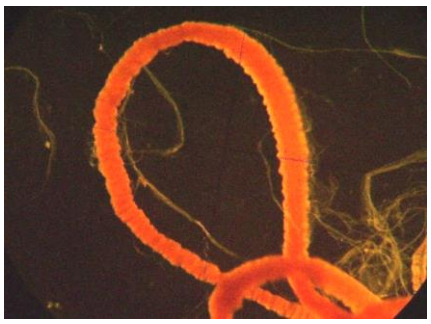

Figure 4. Pf1 virus and cytochrome c microfiber formed in low ionic strength (pH 7, 10mM NaCl)