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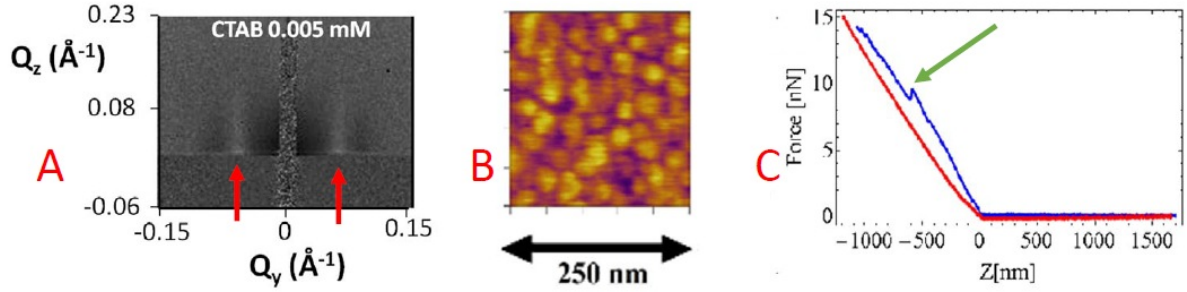
AFM and scattering studies of nanoparticle self-assembly at liquid-liquid interfaces

In recent years, self-assembly at liquid-liquid interfaces has emerged as a very promising route for the production of nano-structured thin film materials and membranes characterized by extraordinary physico-chemical properties and structural response to changing ambient conditions or to deliberate external stimuli. In particular Nano-Particule (NP) membranes produced by interfacial self-assembly at liquid interfaces offer a novel design for industrial applications.

Our team has elaborated a model system of such NP membranes at liquid interfaces, made of aqueous solutions of silica NPs in contact with a bulk phase of immiscible oil, in which the addition of sub-milli-molar concentrations of a cationic surfactant (CTAB) induces the formation of a NP monolayer at the water-oil interface. We have demonstrated that x-ray reflectivity (XRR) yields valuable informations on the NP membrane structural properties, and we have realized for the first time a nanometer scale image of the liquid-liquid interface with the Atomic Force Microscope (AFM), with quantitative information on elasticity and resistance to rupture of the NP membrane.



Objective of the work: The student will study the packing fraction and mechanical properties of the NP membrane at the liquid-liquid interface, in relation with the NPs interaction force monitored by the surfactant concentration. For this purpose the student will be trained in preparing mixed silica-NP/surfactant monolayers at water/oil interfaces, and in state-of-the-art AFM techniques. He/she will be associated to x-ray reflectivity studies of the NPs assemblies. He/she will develop a mechanical model of the deformation and rupture of the membrane to interpretate force and nano-mechanical measurements made with the AFM.

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Student profile: M1 in engineering, physics, chemistry and/or nanosciences.

Future possiblities: PhD with national grant. High grades required in M1 and M2.

Position opened in: october 2016 **Salary:** Official internship rates

Duration: 6 months, more if extended to M2.

Refs: [1] A.K. Boal et al, *Nature* **404**, 746, 2000. [2] Y. Lin et al, *Science* **299**, 226, 2003. [3] S.C. Glotzer et al, *Nat. Mater.* **6**, 557,2007. [4] M.P. Boneschanscher et al, *Science* **344**, 1377, 2014. [5] F. Ravera et al, *Colloids Surf. A* **323**, 99, 2008. [6] D.C.E. Calzolari et al, *Soft Matter* **8**, 11478, 2012. [7] L. Isa et al, *Soft Matter* **9**, 3789, 2013. R. Garcia, *Amplitude modulation atomic force microscopy* 2010, Wiley - VCH. [10] A. Baro and R. Reifenberger, *Atomic Force Microscopy in Liquid: Biological applications* 2012 Wiley VCH. [11] , [12] D. Ramos et al, *J. Appl. Phys.* **99**, 124904, 2006.