International Master in Advanced Clay Science

Master's Thesis Proposal

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Title: **Liquid-crystalline phase behaviour of inorganic metal-oxide imogolite nanotubes**

Imogolite is an inorganic nanotube which occurs naturally on hydrated aluminosilicate form in volcanic soils [1]. Since their discovery, significant progresses have been realized to synthesis imogolite nanotubes (Si-INT) and Ge-analogues (Ge-INT) although several limitations (low yields, small aspect ratios) still prevent their massive use in industrial processes. We have recently demonstrated that micron-long Ge-based double walled INT can be synthesized at high concentrations and can form liquid-crystalline phases due to their large aspect ratio [2] (figure). Furthermore, we can functionnalized both inner and outer surface of INTs leading to new hybrid imogolites. All these remarkable features open the routes towards novel applications as hybrid nanomaterials with specific anisotropy [3].

The aim of this project is to study the liquid-crystalline properties of aqueous suspensions of Ge-INTs at various ionic strengths. Before use, Ge-INT samples will be characterized by IR spectroscopy, X-ray scattering and fluorescence while suspensions will be prepared by applying the ionic strength through dialysis membranes. The phase behaviour of these suspensions will be analyzed over a wide range of volume fractions by combining polarized optical microscopy (POM) and small- and wide-angle X-ray scattering (SAXS/WAXS) experiments. These measurements will allow the candidate to establish a complete phase diagram together with the swelling laws of Ge-INT suspensions. The alignment of the obtained liquid-crystal phases will be explored under external fields (electric or magnetic). To go further, this study could be extended to hybrid Ge-INT with hydrophobic inner ($-CH_3$) or/and outer ($-C_nPO_3H_2$) walls.

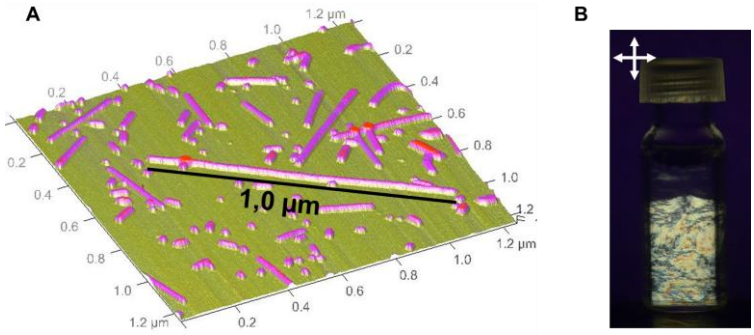

Figure. (a) AFM measurement of the Ge-INT adsorbed on a mica surface. (B) POM image between crossed polarizers of a biphasic imogolite suspension [2].

[1] Yoshinaga & Aomine, Soil Sci. Plant. Nutr., 1962, 8, 22
[2] Amara *et al*, *submitted*
[3] Paineau *et al*, ACS Appl. Mater. Interf., 2012, 4, 4296