International Master in Advanced Clay Science

Master's Thesis Proposal (M2 preferred)

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Physico-chemical properties of synthetic Fe-doped imogolite nanotubes

Imogolite is an inorganic nanotube which occurs naturally on hydrated aluminosilicate form in volcanic soils. Since their discovery, significant progresses have been realized to synthesis imogolite nanotubes (INT) although several limitations (low yields, small aspect ratios) still prevent their massive use in industrial processes. We have demonstrated that micron-long Ge- INT can be obtained at high concentrations [1] and can form liquid-crystalline phases due to their large aspect ratio [2] (Figure). Furthermore, this protocol may be used to substitute Al by iron into the nanotube structure, while keeping anisotropic shape [3]. However, the fate of iron doping on the physico-chemical properties of these nanotubes remains unexplored. It is anticipated that the presence of Fe^{3+} could affect the liquid-crystal phase transitions and/or modify the adsorption and catalytic properties of the outer surface of INT.

This master project aims at determining the properties of these new synthetic imogolite nanotubes. The candidate will have to synthesize Fe-doped Ge-INT [$(OH)_3Al_{2-y}Fe^{III}_yGe(OH)$] with various iron content *y* and to characterize them by coupling Transmission Electron Microscopy, Wide-Angle X-ray Scattering and InfraRed spectroscopy measurements. The phase behaviour of these suspensions will be analyzed over a wide range of volume fractions by combining Polarized Optical Microscopy and Small-Angle X-ray scattering experiments. Surface properties of Fe-doped Ge-INT will be probed with UV-vis spectroscopy by following the interactions with a model azo-dye molecule. These measurements will allow the candidate to establish a complete phase diagram of hybrid Ge-INT suspensions and to determine their surface properties.

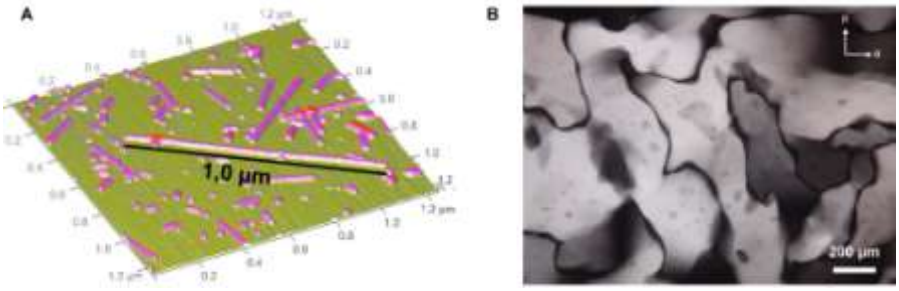

Figure. (a) AFM measurement of Ge-INT adsorbed on a mica surface. [1] (b) POM image between crossed polarizers of a liquid-crystalline phase of imogolite suspension [2].

[1] Amara et al., *Chem. Comm.* 49, 11284 (2013)
[2] Paineau et al., *Nat. Commun.* 7, 10271 (2016)
[3] Paineau et al. *in preparation*