International Master in Advanced Clay Science

Master's Thesis Proposal (M2 preferred)

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Structure of nanoconfined water in synthetic clay nanotubes with tunable inner surface

Molecules, when confined inside nanotubes with diameters comparable to their size, do exhibit most original behaviors. For instance, in hydrophobic carbon nanotubes, ultra-fast water transport was evidenced [1]. A major challenge in this new field of nanophysics, which both raises fundamental questions and opens towards possible applications in water desalination or molecular storage and delivery, is to disentangle the relative roles of the geometry and of the chemical affinity of these nanochannels.

We propose here to study the water structure in single-walled Imogolite clay NanoTube (INT, figure) which can be synthesized with hydrophilic (*n*-INT) or hydrophobic (*m*-INT) inner surfaces, as evidenced recently [2]. The first part of the master's thesis will be devoted to the synthesis of *n*-INT & *m*-INT samples with defined diameters and their characterization by coupling X-ray scattering (XRS) measurements and IR spectroscopy. After the nanocontainers will have been fully characterized, the master's student will study the structure of water confined inside both hydrophilic and hydrophobic SWINT, as a function of the relative humidity, on an original XRS set-up already used successfully to study water structure inside carbon nanotubes [3]. These measurements, coupled to detailed analyses, will allow determining the impact of the interface on the structural properties of water, a fundamental question relevant not only in nanofluidics but also in geology.

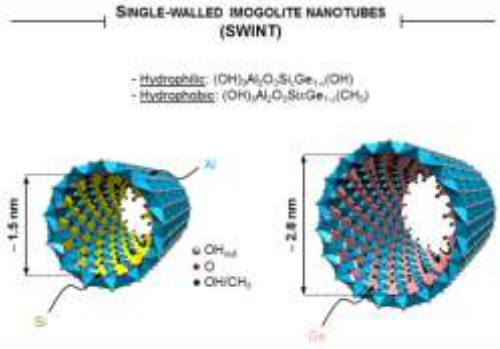

Figure. Atomic structure of hydrophilic imogolite nanotubes $(OH_{out})_3Al_2O_3Si_xGe_{1-x}(OH_{in})$. *Replacement of inner hydroxyl groups* OH_{in} *by methyl ones make it hydrophobic.*

[1] (a) Majumder et al., *Nature* 438, 44 (2005); (b) Holt et al., Science 312, 1034 (2006)
[2] Amara et al., *Chem. Mater.* 27, 1488 (2015)
[3] Paineau et al., *Nano Letters* 13, 1751 (2013)