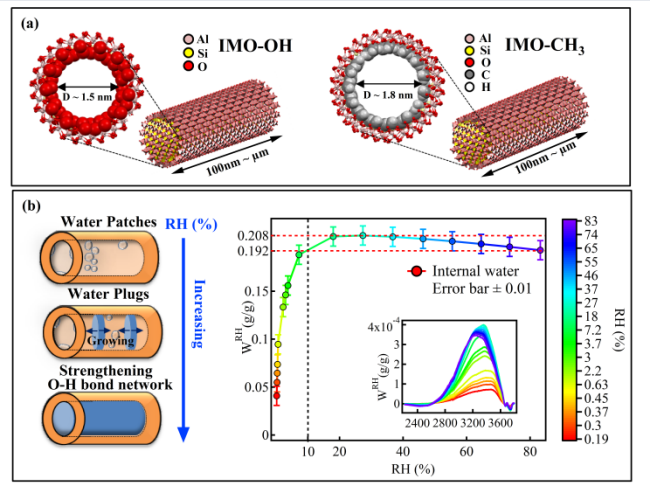
Properties of Water Confined in Standard and Hybrid Imogolites Revealed by Infrared Spectroscopy

Yuan-Yuan Liao, Pierre Picot, Antoine Thill, Sophie Le Caër (LIONS, CEA), Jean-Blaise Brubach, Pascale Roy (Synchrotron SOLEIL).

Imogolite is a natural nanotubular aluminum silicate clay mineral, originally found in volcanic soils. Its well-defined, yet tunable structure makes it a good candidate for the study of water confined in a one-dimensional structure. Two types of synthetic imogolites were investigated: a pristine imogolite (IMO-OH) with a hydrophilic inner surface fully covered with Si-OH groups and a hybrid imogolite (IMO-CH_3) with a hydrophobic inner surface fully covered with Si–CH_3 groups. Both imogolites have the same outer surface, covered with Al-OH groups. The structures are presented in Figure (a).



We succeeded in producing self-sustaining thin films of imogolites. The behavior of water confined in these films was then studied by infrared spectroscopy in the 20-4000 cm^{-1} spectral range as a function of relative humidity (RH, %). The water adsorption properties were determined and compared in details for both imogolites. By using the typical external water spectrum deduced for IMO-CH3, we have successfully extracted the spectrum of water confined within IMO-OH nanotubes. Figure (b) shows then the water adsorption isotherm of water confined inside IMO-OH and the corresponding IR spectra obtained during the water-adsorption process.

The water filling inside IMO-OH follows these steps: I) Water molecules adsorbed to silanol groups on the internal surface, start to form patches. II) Those water patches merge into a monolayer over the entire internal surface. III) Those patches grow and then form plugs. IV) Pores are filled with water.

Lastly, insights into the relationship between (1) the large specific surface area, (2) restricted geometries, (3) the tunable hydrophilicity, can serve the scientific community interested in deploying these materials for applications such as membranes, catalyst supports, adsorbents, etc.

Y-Y. Liao; P.Picot; J.-B. Brubach; P. Roy; S. Le Caër, A. Thill, *Self-supporting thin films of imogolite and inogolite-like nanotubes for infrared spectroscopy,* Applied Clay Science (2017)

Y-Y. Liao; P.Picot; M. Lainé; J.-B. Brubach; P. Roy; A. Thill; S. Lew Caër, *Tuning the Properties of Confined Water in Standard and Hybrid Nanotubes: an Infrared Spectroscopic Study,* submitted (2017)

Résultats obtenus dans le cadre du projet ECRIN financé par le thème émergence du LabEx PALM et porté par Sophie Le Caër (NIMBE, CEA), Pascale Roy (SOLEIL) et Mehran Mostafavi (LCP, CNRS).