



**HAL**  
open science

# Methyl-imogolite: a new hybrid nanotube for water remediation

Pierre Picot, Thibaud Coradin, Antoine Thill

► **To cite this version:**

Pierre Picot, Thibaud Coradin, Antoine Thill. Methyl-imogolite: a new hybrid nanotube for water remediation. Interfaces Against Pollution (IAP 2018), Jun 2018, La Grande Motte, France. cea-02339933

**HAL Id: cea-02339933**

**<https://cea.hal.science/cea-02339933v1>**

Submitted on 30 Oct 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Methyl-imogolite: a new hybrid nanotube for water remediation

Pierre PICOT<sup>1</sup>, Thibaud CORADIN<sup>2</sup>, Antoine THILL<sup>1</sup>

<sup>1</sup> LIONS, NIMBE, CEA, CNRS, Université Paris-Saclay, Gif-sur-Yvette 91191, France

<sup>2</sup> Sorbonne Universités, UPMC Univ. Paris 06, CNRS, Collège de France, Paris 75005, France

E-mail contact: pierre.picot@cea.fr

Imogolite is a natural aluminosilicate nanotube discovered in 1962 by Yoshinaga and Aomine in volcanic Japanese soils [1]. This nanotube has a monodisperse diameter ranging from 2 and 2.8 nm (depending on its formation and composition) and a polydisperse length (from a few tens of nanometers to several microns) [2]. In recent years, it has been realised that many structural and chemical modifications of imogolite-like structures can be achieved [3,4]. In 2010, Bottero et al. succeeded in modifying the tube internal surface by substituting the usual silicon precursor, tetraethoxysilane, with a methyltriethoxysilane [5]. This allows for the formation of a methyl-imogolite (imo-CH<sub>3</sub>) with a hydrophilic external surface and a hydrophobic internal surface covered with methyl groups. This nanotube, transparent and dispersed in water even at high concentration, exhibits a 1D hydrophobic polar nanochannel [6].

In 2013, Amara et al. showed that such Janus nanotubes can capture small hydrophobic molecules in water [7]. Later on, we showed that these hybrid nanotubes can stabilise oil-in-water Pickering emulsion and extract a dye from an organic phase [8]. These properties were attributed to the ability of methyl-imogolites cavities to accommodate oil or oil/dye mixtures (figure 1).

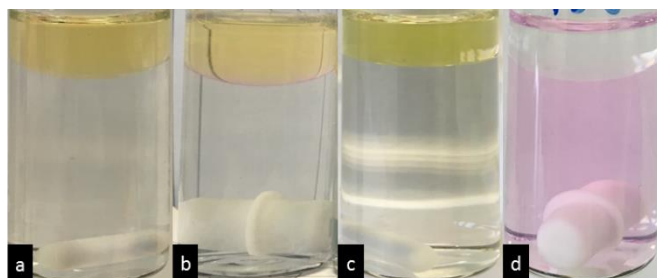


Figure 1: Hexane/Nile Red solutions in contact with water and with imo-CH<sub>3</sub> just after preparation (a) and (b) and three days after stirring (c) and (d)

In this presentation, we will show optimized recipes to produce imo-CH<sub>3</sub> and that it is possible to synthesize new hybrid imogolite nanotube with some of methyl groups substituted by exotic groups. The presence of these new groups is highlighted by the solvatochromic properties of Nile Red. Next, we will assess the water remediation potential of these new nanotubes through comparative trapping of atrazine between hybrid imogolites and activated carbon

## References (optional)

- [1] Yoshinaga N., Aomine S., *Imogolite in some Ando soils*. Soil Science and Plant Nutrition 8 (1962) 22-29.
- [2] Wada S., *Imogolite synthesis at 25°C*. Clays and Clay Minerals 35 (1987) 379-384.
- [3] Wada S., Wada K., *Effects of substitution of germanium for silicon in imogolite*. Clays and Clay Minerals 30 (1982) 123-128.
- [4] Avellan A., Levard C., Kumar N., Rose J., Olivi L., Thill A., Chaurand P., Borschneck D., Masion A., *Structural incorporation of iron into Ge-imogolite nanotubes: a promising step for innovative nanomaterials*. RSC Advances 4 (2014) 49827-49830.
- [5] Bottero I., Bonelli B., Ashbrook S., Wright P., Zhou W., Tagliabue M., Armandi M., Garrone E., *Synthesis and characterization of hybrid organic/inorganic nanotubes of the imogolite type and their behaviour towards methane adsorption*. Physical Chemistry Chemical Physics 13 (2011) 744-750.
- [6] Poli, E.; Elliott, J. D.; Ratcliff, L. E.; Andrinopoulos, L.; Dziedzic, J.; Hine, N. D. M.; Mostofi, A. A.; Skylaris, C. K.; Haynes, P. D.; Teobaldi, G., *The potential of imogolite nanotubes as (co-)photocatalysts: a linear-scaling density functional theory study*. Journal of Physics-Condensed Matter 28 (2016) 17.
- [7] Amara M., Paineau E., Rouziere S., Guiose B., Krapf M., Tache O., Launois P., Thill A., *Hybrid Tunable-Diameter Metal-Oxide Nanotubes for Organic Molecules Trapping*. Chemistry of Materials 27 (2015) 1488-1494.
- [8] Picot P., Taché O., Malloggi F., Coradin T., Thill A., *Behaviour of hybrid inside/out Janus nanotubes at an oil/water interface. A route to self-assembled nanofluidics?*. Faraday Discussions 191 (2016) 391-406.