Mechanisms of structural reordering during thermal transformation of aluminogermanate imogolite nanotubes

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Metal oxide aluminosilicate and aluminogermanate nanotubes, called imogolite nanotubes (INT), are nanotubes with well-controlled diameter and with different morphologies [1,2]. These nanotubes undergo major structural changes at high temperatures, including the transformation from one-dimensional nanochannels into a structure which is supposed to be lamellar [3,4].

Here, we report a complete analysis of the structural transformations of single and double-walled aluminogermanate nanotubes, up to 900°C. We applied an original approach combining (i) in-situ X-ray absorption spectroscopy measurements (LUCIA & DiffAbs beamlines, synchrotron SOLEIL), allowing us to investigate the evolution of both Al and Ge atoms coordination during the transformation process, and (ii) in-situ diffraction. It reveals that the dehydroxylation of nanotubes does not lead to a lamellar phase but to metastable intermediate states that we named "meta-imogolite" states by analogy with meta-kaolinite. A mechanism explaining the major structural reorganizations is proposed based on atomic jump processes. The understanding of these structural modifications represents a benchmark for further studies concerning the properties of transformed INT-based compounds.

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