AN OLD MATERIAL IN THE NANOWORLD: ORGANIC-INORGANIC HYBRID NANOTUBES BASED ON γ- TITANIUM PHOSPHATE LAYERED STRUCTURE

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Since the great success of carbon nanotubes in 1991, interest in low-dimensional nanomaterials has fuelled a spectacular and unusual activity [1]. Nowadays the nanotubes are not only made of carbon but also of inorganic materials [2], many of which are related with previously well-known layered structures. On the other hand, although only two crystalline structure of layered Ti-phosphate are found, α-$Ti(HPO_4)_2 \cdot H_2O$ and γ-$Ti(PO_4)(H_2PO_4) \cdot 2H_2O$, many derivatives as partially and completely substituted ion-exchanged forms and intercalated compounds have been reported [3]. The layered γ-titanium phosphate is an acid solid amenable to intercalation processes of basic species (see Fig. 1). In fact, more than a decade ago, we described a mechanism of intercalation of *n*-alkylamines in γ-titanium phosphate, showing that most of the P-OH groups have an important tendency to interact with amine groups of the guest molecules [4]. In this way, compounds with formula γ-$Ti(PO_4)(H_2PO_4) \cdot 1.3C_nH_{2n+1}NH_2 \cdot H_2O$ (with n ranking from 1 to 6) can be synthesized.

In this contribution we report on the synthesis of organic-inorganic hybrid nanotubes based on the γ-titanium phosphate structure spaced with trialkylamines. These materials have been prepared by using microemulsion-mediated solvothermal and microwave-assisted methods. The interlayer distance in the inorganic sheets of the nanotube can be controlled by both the alkyl chain length and the amount of the amine template. All nanotubes obtained are open-ended. Cross-sectional TEM images (see Fig. 2) of these nanotubular phases show that the tubes are made up of concentric cylinders, i.e., layers that fold and close within themselves. The possible reason for having this morphology seems to be related to the combination of two factors: *i)* the interaction between the nitrogen of trialkylamine molecules and the hydrogen belonging to inorganic skeleton that seeks to be maximum, and *ii)* the pseudo-conical geometry of the trialkylamine molecules that limits the number of accessible acid centers (see Fig. 3). In this way, the number of H-N links will depend on the length of the alkyl chain.

Further studies using synchrotron powder x-ray diffraction in tandem with high-resolution NMR spectroscopy will provide information on the local environment in the inorganic-organic link for the formation of these new γ-titanium phosphate based nanotubes.

References:

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Figures:

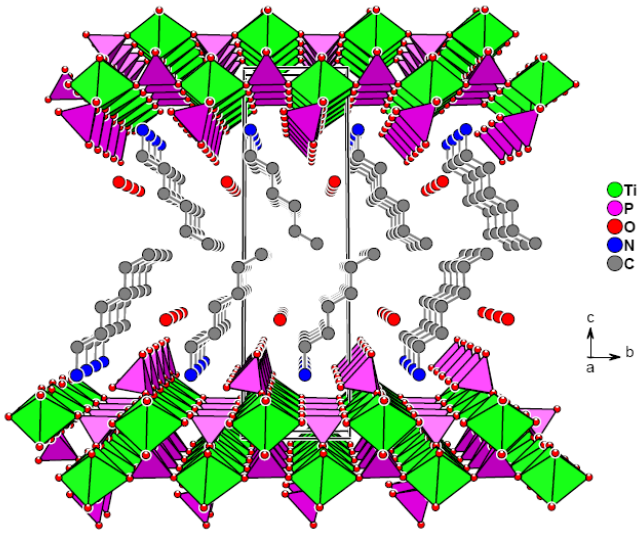

Fig. 1.- Schematic view of the γ-Ti(PO_4)(H_2PO_4)·$C_6H_{13}NH_2$·H_2O structure.

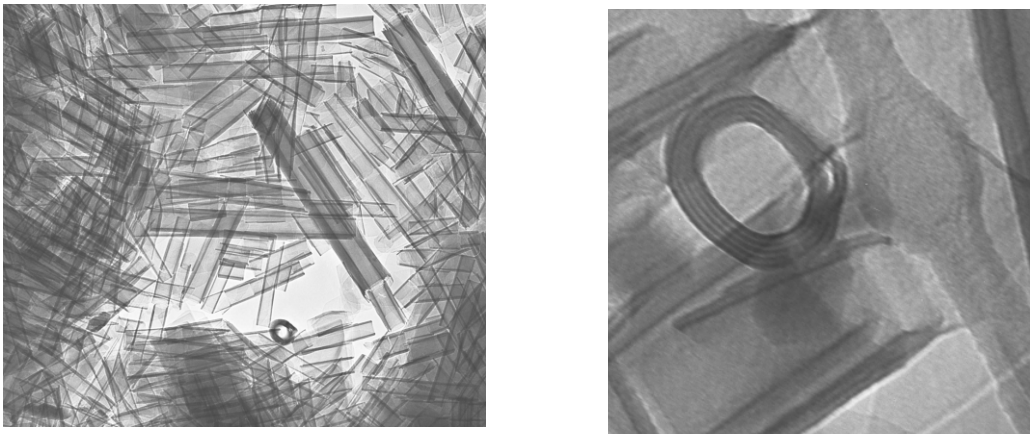

Fig.2.- TEM images of the trialkylamine/γ-titaniumphosphate hybrid nanotubes showing concentric cylinder-like scrolls.

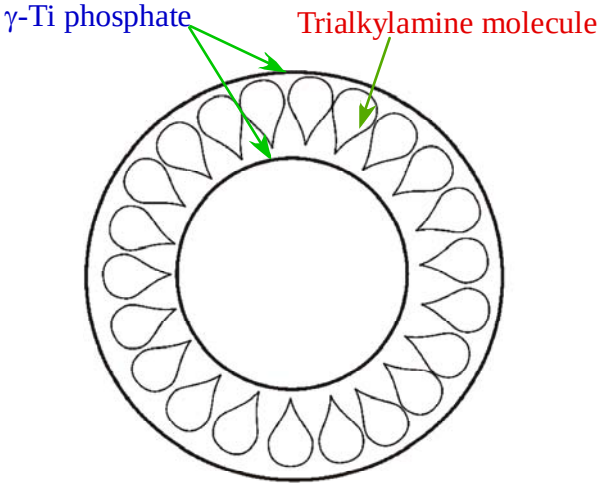

Fig. 3.- Model of curved lattice for trialkylamine/γ-titaniumphosphate hybrid nanotubes.