Poster

MICRO- AND NANO-SCALE TUBULAR OXIDE STRUCTURES

[1]Martin Järvekülg, [1,2]Valter Reedo, [2]Uno Mäeorg
[1]Institute of Physics, University of Tartu, Riia 142, 51014 Tartu, Estonia
[2]Institute of Organic and Bioorganic Chemistry, University of Tartu, Jakobi 2, 51014 Tartu, Estonia
martinj@fi.tartu.ee

Nano- and microscale tubular structures have exceptional properties and have great potential as the building blocks of nano- and microdevices systems of high efficiency. For that this kind of structures have been the subject of intensive research. Since the discovery of carbon nanotubes [1] there has been active interest in exploring other layered and nonlayered materials that form tubular structures. Many different methods of obtaining various materials in nanotube form have been reported and summarized in reviews [2].
TiO2, ZrO2 and HfO2 are wide band gap materials of great interest since they can be used in sensorics, photocatalysis, electronics and solar cells. Metal oxide nanotubes have been obtained through various sol-gel related methods, in both basic and acidic conditions and different synthesis temperatures. The suggested formation models are often complemented or corrected afterwards [3]. Obviously, exploring different possibilities for obtaining tubular nano- and micro-sized materials and explaining their formation is of great importance in order to establish correct theories and be able to synthesize materials with desired properties.
In present work we report a novel phenomenon and mechanism of low-dimensional tubular oxide structure formation. Microtubes of hafnium oxide were obtained by rapid vaporization of solvents from prepolymerized hafnium butoxide sols at relatively low temperatures (~ 100 °C) whereas the pre-polymerization was carried out by adding a solution of water and hydrochloric acid in butanol to the alkoxide. This kind of treatment led to the formation of microtubular oxide structures. Experiments were carried out using titanium and zirconium butoxides in a similar way, the different amounts of hydrochloric acid were added and various vaporization programs were used.
Obtained micro- and nanostructures were characterized by electron microscopy. The crystal structure was investigated by XRD. Most of the tube-like structures observed were 20-200 µm in length and 2- 10 µm in diameter. SEM images indicated that the oxidic structures have have a nature of rolled-up nanosheets. Some possible tube-forming mechanisms are also presented to explain the formation of observed structures.
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References:

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[3]Kukovecz, A., Hodos, M., Horvath, E., Radnoczi, G., Konya, Z., Kiricsi, I. Oriented Crystal Growth Model Explains the Formation of Titania Nanotubes. J. Phys. Chem. B, **109** (2005) 17781-17783.

Figures:

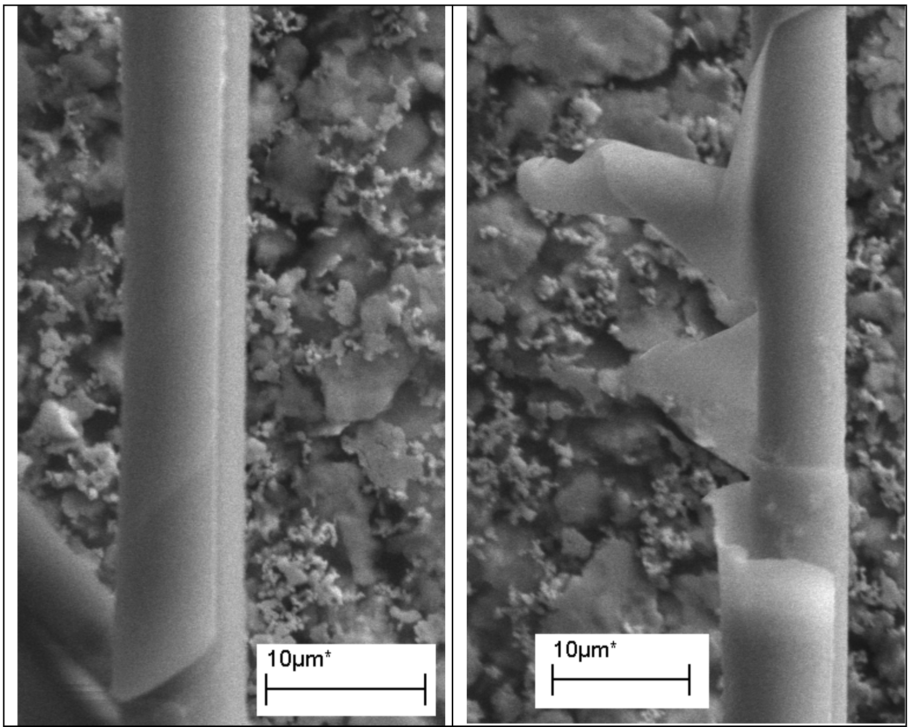

Fig. 1 SEM images of rolled-up HfO_2 structures

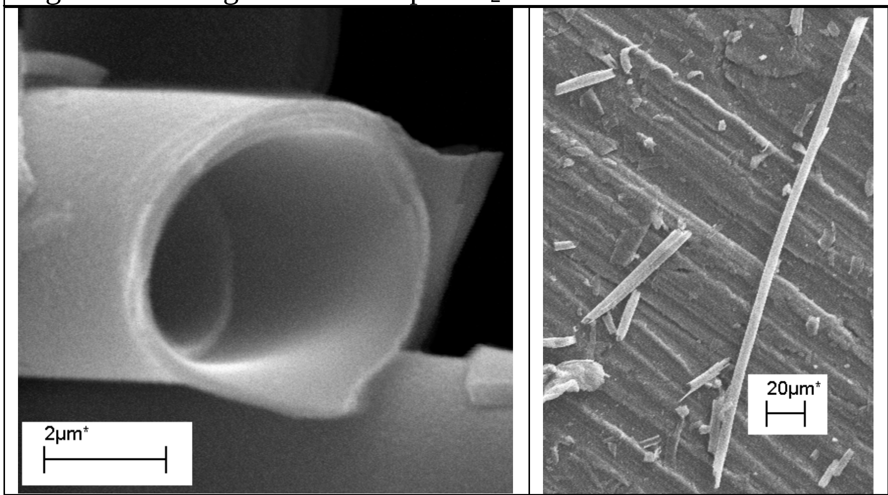

Fig. 2 SEM images of tubular ZrO_2 structures.