

11th International Conference on Advanced Materials Rio de Janeiro Brazil September 20 - 25

Hydrothermal growth of Zirconia Nanostructures

V. M. Fuenzalida^{(1)*}, C. González⁽¹⁾, D. Diaz-Droguett⁽¹⁾ and R. Espinoza⁽²⁾

- (1) Departamento de Física FCFM, Universidad de Chile, e-mail: vfuenzal@ing.uchile.cl
- (2) Departmento de Ciencia de Materiales, FCFM, Universidad de Chile
- * Corresponding author.

Abstract – Zirconia microrods and sodium titanate nanostructures have been synthesized hydrothermally. The process is performed in an autoclave at very high pH using NaOH as a mineralizer. The temperature of the treatments spanned from 130 °C to 200 °C and their duration from 18 h to 1 week. The use of titania as base material leads to the formation of sodium titanate nanowires. The use of zirconium monoxide as base material lead to ZrO2 bara, 200 nm in diameter, with no sodium incorporation in the structure.

Titanium dioxide-based nanostructures have been produced under hydrothermal techniques by several authors, many of them based on Kasuga's method [1]. It consists in placing fine TiO₂ particles (rutile or anatase) in an aqueous Na(OH) solution inside a sealed reactor, at temperatures between 100 and 160 °C. Depending on the subsequent treatment (annealing, washing with HCl) several compounds are produced, mainly sodium and hydrogen titanates.

There are fewer reports on the hydrothermal preparation of zirconia nanostructures. This is probably due to the higher stability of zirconia under hydrothermal conditions. In fact, the preparation of barium zirconate films under hydrothermal conditions requires temperatures as high as 200 °C [2], as compared with the 80 °C required for barium titanate under similar conditions [3]. Nevertheless Kanade et al. [4] and Kumari el al. [5] reported on the hydrothermal synthesis of monoclinic ZrO_2 nanoparticles starting from ZrO_2 powder.

We report on the preparation of ZrO_2 nanorods starting from zirconium monoxide ZrO as base material. The hydrothermal process was performed putting 0,25 g of ZrO in each of three different teflon beakers containing NaOH solutions of nominal concentrations of 15, 20 and 25 M. The bakers were placed simultaneously inside an autoclave and heated at 200 °C for seven days. The products were washed with deionized water until the liquid exhibited neutral pH.

X-ray photoelectron spectrometry revealed zirconium in its oxidation state IV and oxygen, but not sodium or other contaminants. X-ray diffraction revealed monoclinic ZrO₂. The absence of contaminants was corroborated by x-ray dispersive spectrometry. Transmission electron microscopy showed bar-shaped particles with thickness between 100 and 200 nm, apparently grown on the surface of the precursor powder.



[1] T. Kasuga, M. Hiramatsu, A. Hoson, T. Sekino and K. Niihara, Langmuir 14 (1998) 3160.

[2] A. V. Alvarez and V. M. Fuenzalida, J. Mat. Res. 14 (1998) 11.

- [3] T. Hoffmann, Gultzow, C. M. Sotomayor-Torres, T. Doll and V. M. Fuenzalida, Mat. Sci. Semicond. Process. 2 (1999) 335.
- [4] K. G. Kanade, J. O. Baeg, S. K. Apte, T. L. Prakash and B. B. Kale, Mat. Res. Bulletin 43 (2008) 723.

[5] L. Kumari, W. Li, D. Wang, Nanotechnology 19 (2008) 195602.