STRUCTURAL TRANSFORMATION FROM TITANIA NANOPARTICLES TO SODIUM TITANATE NANOSHEET EXHIBITING SENSING PROPERTIES

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TiO_2-based nanomaterials, such as titanium dioxide and layered titanates, are increasingly used in nanotechnology due to biological and photochemical stability, catalytic activity, non-toxicity and cost-effectiveness. In addition, it is known that some titanates can be used for humidity sensors regarding hydrophilic nature of their surface [1].

Nine TiO_2-based products were obtained by the hydrothermal treatment of starting nanoanatase using NaOH solution (c = 5 mol cm^{-3}) under different conditions (from 6 h at 110 °C to 18 h at 160 °C). Such optimization was necessary in order to obtain single sodium titanate phase allowing the testing of sensing properties but also long time waited distinction between titania and titanates in terms of structural and microstructural properties.

The intensification of hydrothermal treatment notably increased the solubility of nanoanatase causing the phase and morphology transition from nearly spherical titania nanoparticles into elongated titanate nanosheets. According to XRPD and HRTEM/SAED, the single titanate phase was prepared after the most energy-intensive treatment, *i.e.* at 160 °C for 18 h. The $Na_{0.4}H_{1.6}Ti_2O_5 \cdot H_2O$ could be ascribed as its formula, based on EDS and TG. The phase composition and crystallite size were calculated in Jade software for all nine samples while unit cell parameters of single-phased sodium titanate were obtained by Rietveld refinement using FullProf software in Winplotr environment. The calculated unit cell parameters of sodium titanate, a = 18.16(7) Å, b = 3.754(7) Å, c = 2.99(1) Å, show the slight elongation along a-axis comparing to $H_2Ti_2O_5 \cdot H_2O$ (PDF card No. 47-0124) probably due to partial Na^+–H^+ ion exchange. The TG and FTIR analyses showed the hygroscopic nature of $Na_{0.4}H_{1.6}Ti_2O_5 \cdot H_2O$ nanosheets revealing the water adsorption on surface. Hence, the obtained $Na_{0.4}H_{1.6}Ti_2O_5 \cdot H_2O$ was for the first time used to produce a humidity sensor, which displayed remarkably rapid response and very fast recovery time.

[1] K. Kordas, M. Mohl, Z. Konya, A. Kukovec, *Layered titanate nanostructures: perspectives for industrial exploitation*, Translational Materials Research, 2 (2015) 015003/1–18.

Keywords: TiO_2 nanoparticles, sodium titanate nanosheets, humidity sensor