Nanocomposites and nanomaterials

Tin dioxide based nanomaterials: synthesis, modification, physico-chemical and sensor properties

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Nanosized tin dioxide is a perspective material for catalysis, adsorption and creation of semiconductor gas sensors. Sensitivity of such sensors depends on a specific surface area (SSA), particle size of sensor nanomaterials, temperature conditions of formation of semiconductor nanomaterials and sensors created on their base. The aim of this work is to study influence of preliminary mechanochemical treatment of SnO_2 xerogel on physical-chemical and gas sensitive properties of the nanomaterials based on SnO_2.

In this work gel of tin oxide was homogeneously precipitated using urea. Synthesized xerogel was subjected to mechanochemical treatment in air (MChT-air) and water (MChT-water) at 600 rpm at planetary ball mill Pulverisette-7. As-synthesized and milled samples were annealed stepwise in a temperature range 20–550°C in air.

Preliminary MChT of SnO_2 contributes to some increase in SSA for annealed samples: from 26 m^2/g for initial sample to 29 and 38 m^2/g for samples milled in air and water, respectively. On the other hand, size of crystallites calculated using Sherrer's formula decreases from 11 nm for the initial sample to 7-8 nm for modified samples after mechanochemical treatment. The sensors were created on the base of the obtained SnO_2 samples and nanomaterials which were additionally modified by $CoCl_2$ solution ($6 \cdot 10^{-2}$ M). It was found that sensors on the base of SnO_2 (MChT-water) nanomaterial have the highest sensitivity values in comparison with the sensors obtained from initial SnO_2 and SnO_2 (MChT-air) materials. The introduction of cobalt additives to gas sensitive layers of the sensors leads to an increase in their sensitivities to 40 ppm H_2 in air. The highest sensitivity was found for sensors based on Co/SnO_2 (MChT-water) nanomaterial with the greatest SSA and smallest particle size of these materials.