

Sensors and Actuators B: Chemical

Facile synthesis of improved room temperature gas sensing properties of TiO₂ nanostructures: Effect of acid treatment

Z.P. Tshabalala^{a,b}, D.E. Motaung^{a,*}, G.H. Mhlongo^{a,*}, O.M. Ntwaeaborwa^{b,*}

^a DST/CSIR, National Centre for Nano-structured Materials, Council for Scientific Industrial Research, Pretoria 0001, South Africa

^b Department of Physics, University of the Free State, P.O. Box 339, Bloemfontein ZA9300, South Africa

Abstract

TiO₂ nanoparticles were synthesized via a simple hydrothermal method in a sodium hydroxide (NaOH) aqueous solution and washed with distilled water and different concentrations of hydrochloric acid which acted as the morphological/crystallographic controlling agent. Microscopy analysis showed that the size of the TiO₂ nanoparticles could be easily tailored and tuned by varying the HCl concentration. The phase transformation from a mixture of anatase and rutile phases to pure anatase phase was observed at higher HCl concentration. The particle sizes were reduced while the Brunauer–Emmett–Teller surface area increased when increasing the HCl concentration, thus resulting in higher sensing response and selectivity to NO₂ at room temperature. The X-ray photoelectron spectroscopy, photoluminescence and electron paramagnetic resonance studies also revealed that the 1.0 M sample contain high relative concentration of oxygen vacancy and Ti⁴⁺ and Ti³⁺ interstitial defect states which played a vital role modulating the sensing properties.