

Photoconductive properties of nanocrystalline TiO₂ powders prepared in acidic environment

T. Georgakopoulos^{1*}, N. Todorova², C. Trapalis² and K. Pomoni¹

¹Department of Physics University of Patras, 26500 Patras Greece

²Institute of Nanoscience and Nanotechnology, National Centre for Scientific Research "Demokritos" 15343, Ag. Paraskevi Attikis, Greece

For the preparation of the samples in acidic environment, 3.32 mL TBO were digested in 100 mL of 0.5 M aqueous solution of sulphuric acid (SA) for 30 min under vigorous stirring at room temperature. Then, the solution was poured into a 100 mL Teflon-lined autoclave occupied 80% of its volume. Two different solution heat treatments were used, the first at 180 °C for 10h and the second at 180 °C for 24h. Moreover, TiO₂ nanocrystalline powder, TiO₂-W, was prepared in neutral environment. After natural cooling to room temperature, the powder products were washed with distilled water to neutral conditions, and then dried at 70 °C for 24 h. The powders obtained were abbreviated as sample TiO₂-SA 10h and TiO₂-SA 24h, respectively. By means of XRD measurements the phase of the TiO₂-SA samples was found only anatase, in agreement with Z. Zhao et al., while for TiO₂-W a mixture of anatase and brookite phase was identified.

Fig.1 shows the diffuse reflectance spectra. The effective band gap of these samples was estimated from the absorption function $[f(R) \times E]^{1/2}$ was plotted against E (eV), where $F(R) = (1 - R)^2 / 2R$ is the Kubelka-Munk function expressed through the measured diffuse reflectance R (fig.2).

The transient photoconductivity (σ_p) of the samples TiO₂-SA 10h, TiO₂-SA 24h and TiO₂-W, in vacuum at 300K, is illustrated in Fig.3. The σ_p of all samples after a quick rise show the usual sublinear behavior indicating the competition between photogeneration, recombination and thermal release rates [2]. The TiO₂-SA samples present higher σ_p values when compared to TiO₂-W sample attributed to their anatase phase [3]. The TiO₂-SA 24h sample reaches larger σ_p values (fig. 4) due to the better nucleation and growth because of the prolonged reaction time [1].

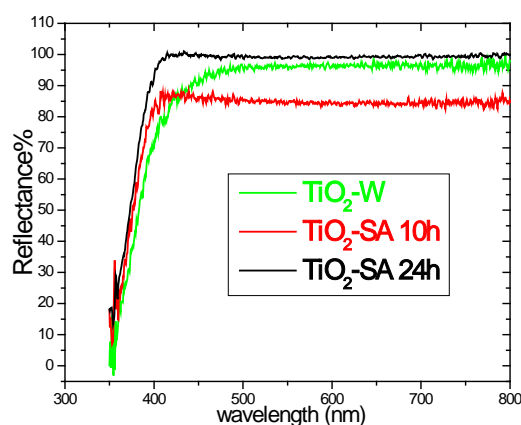


Fig.1. Measured diffuse reflectance spectra of the samples TiO₂-W, TiO₂-SA 10h and TiO₂-SA 24h

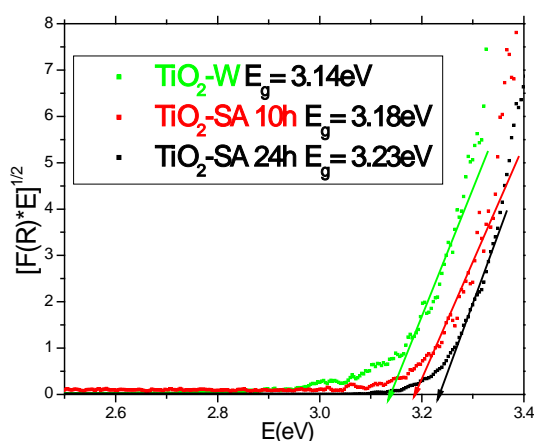


Fig. 2. Absorption function $[f(R) \times E]^{1/2}$ vs energy E for the samples TiO₂-W, TiO₂-SA 10h and TiO₂-SA 24h

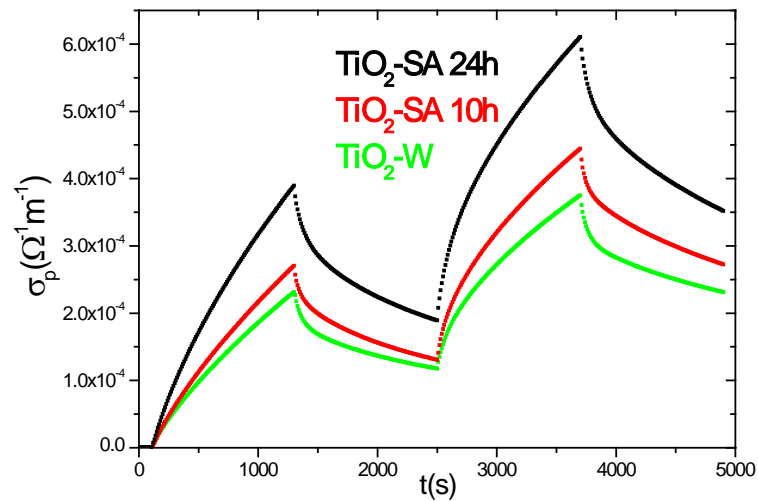


Fig.3. The photoconductivity response at 300K, in vacuum, of the samples TiO_2 -SA 24h, TiO_2 -SA 10h and TiO_2 -W

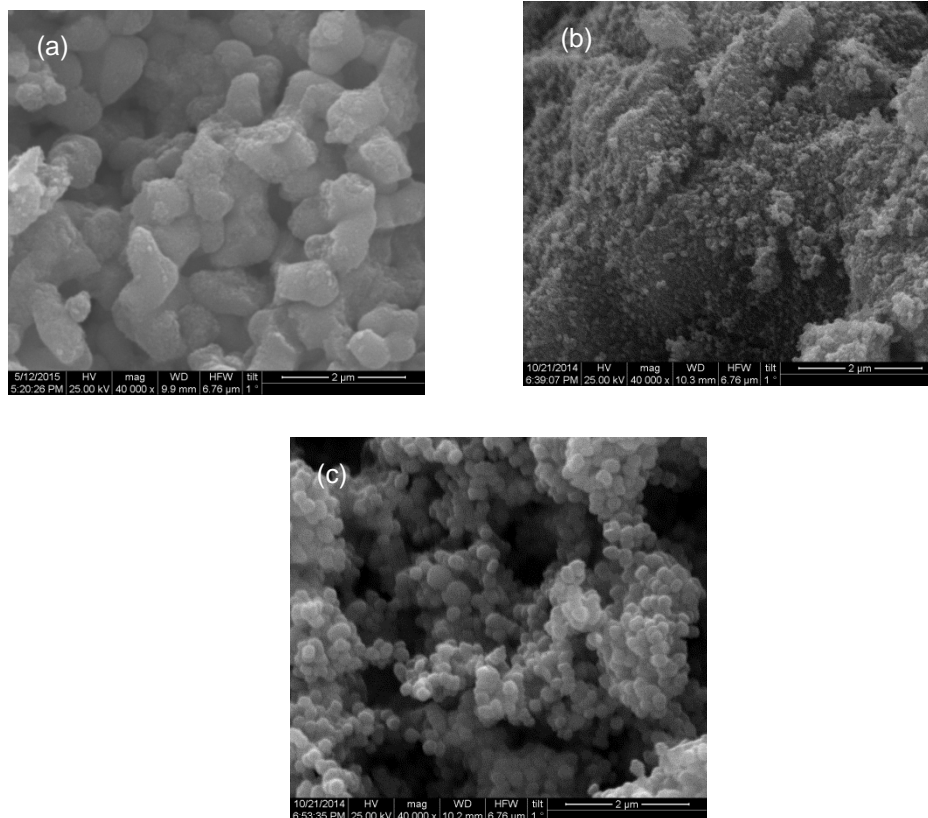


Fig.4 SEM images of samples a) TiO_2 -W, b) TiO_2 -SA 10h and c) TiO_2 -SA 24h

References

- [1] Z. Zhao, Z. Sun, H. Zhao, M. Zheng, P. Du, J. Zhao and H. Fan, J. Mater. Chem. 22 (2012) 21965-21971
- [2] K. Pomoni, T. Georgakopoulos, M.V. Sofianou, C. Trapalis, J. Alloys Compd. 558 (2013) 1-5
- [3] C. Colbeau-Justin, M. Kunst, D. Huguenin, J. Mater. Sci. 38 (2003) 2429-2437