Microstructural and photocatalytic properties of nanocrystalline TiO_2 prepared by precipitation

Iolanda Cimieri, Dirk Poelman

LumiLab, Department of Solid State Sciences, Ghent University, Belgium

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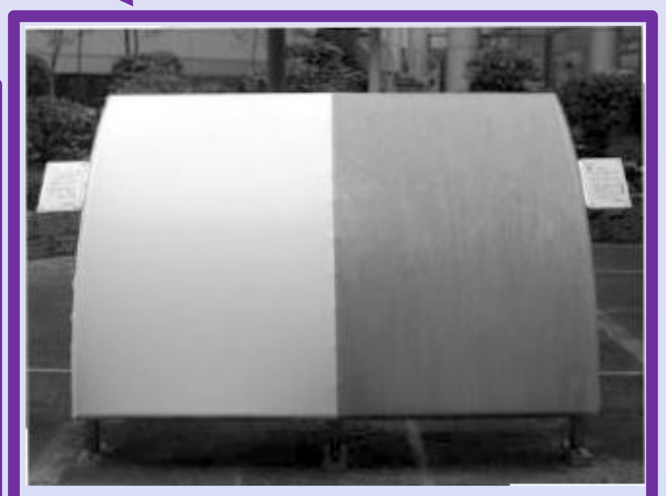
TiO_2 applications

Bactericidal

Anti-fogging glass



Self-cleaning

Environmental remediation

in solution

in gas phase

e.g.degradation of VOCs

Materials and method

Crystalline TiO_2 powders were prepared by precipitation from an aqueous $TiOCl_2$ solution, obtained through reaction between $TiCl_4$ and water:

$$TiCl_4 + H_2O \rightarrow TiOCl_2 + 2\,HCl\uparrow$$

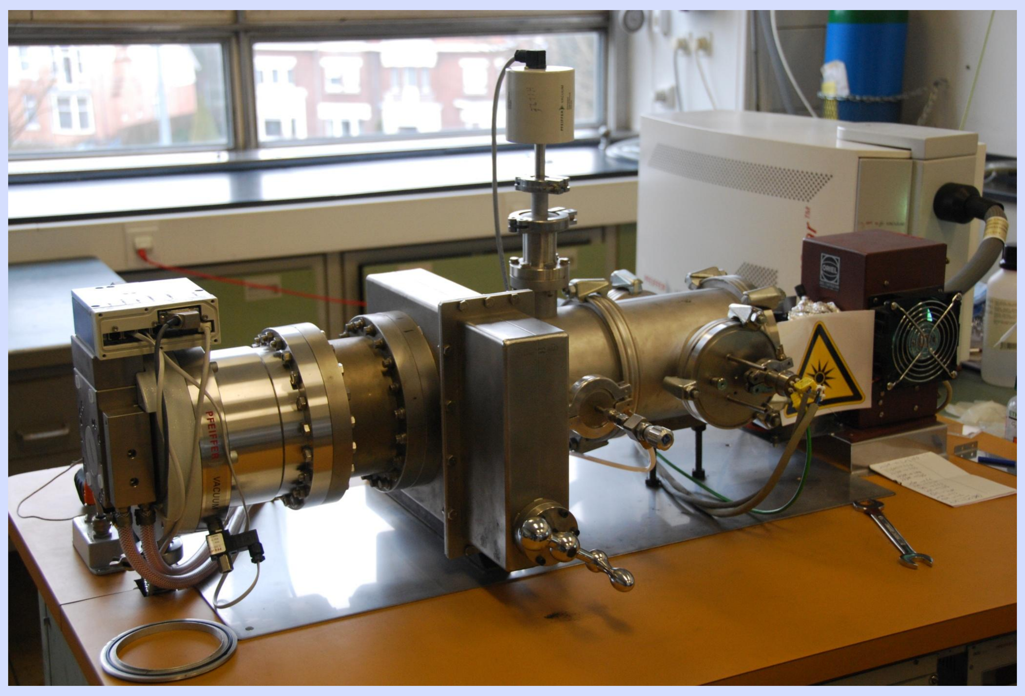
Different amounts of $TiOSO_4$ were added to enhance the formation of the anatase phase, before the direct hydrolysis to $Ti(OH)_4$. The films were prepared by spin coating, heat treated at 400 °C in air and compared with that obtained for a sample of P25 Degussa.

The effect of a non-ionic surfactant molecule (Triton X-100) has been evaluated.

Analysis

The films were characterized by X-ray diffraction, scanning electron microscopy, UV-Vis spectroscopy and ellipsometry. The photocatalytic measurements were carried out in a stainless steel batch reactor in a controlled Ar/O_2 atmosphere (ratio 80:20 to simulate air).

The breakdown reaction for EtOH (test substance) was monitored by means of an atmospheric gas analyser containing a mass spectrometer. The light source used was a mercury high-pressure short arc lamp.



Results

Sample	$[SO_4^{2-}]$ (mol/l)	Crystallization phase	Photocatalytic activity ± 3σ (ppm/min)
A	0.02	rutile	2.60±0.26
B	0.04	anatase	3.52±0.09
C	0.07	anatase	3.18±0.13
D	0.1	amorphous	0.21±0.07
P25	-	80% anatase-20% rutile	3.44±0.16

A concentration of SO_4^{2-} equal to 0.04 and 0.07 promotes the formation of anatase phase. The porous films obtained from this nanocrystalline TiO_2 show quite good photocatalytic activity for the degradation of EtOH compared to titania films prepared using P25 Degussa. A lower concentration leads to a less active rutile phase whereas a higher one to amorphous phase which hardly shows any activity.

Conclusions

- This cheap and scalable synthesis method yields nanocrystalline TiO_2 particles with a high surface area.
- Tuning the amount of added SO_4^{2-} ions, it is possible to obtain different crystallization phases.
- Triton X-100 addition improves the break-up of the particles agglomeration and it eases the colloid deposition on glass substrate. However, it prevents crystallization of anatase or rutile and therefore its addition leads to very low activity.

Acknowledgements

This work was carried out under the Interuniversity Attraction Pole programme IUAP VI/17-INANOMAT funded by the Belgian Science Policy and was also supported by FWO–Flanders.

Contact: iolanda.cimieri@ugent.be