Structural and photocatalytic behavior of thermally stable SiO_2@TiO_2 core-shell particles

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TiO_2 photocatalytic activity closely depends on physical properties such as surface area, crystallinity, morphology, particle size and crystalline phase of titania, with anatase being the most active photocatalytic polymorph of TiO_2[1]. In order to make possible the use of TiO_2 photocatalysts in different applications it is important to develop synthetic strategies that allow control over such physical properties, especially in the case of nanometric TiO_2, which suffers from drawbacks such as tendency to agglomeration, phase transformation and decrease in surface area upon thermal treatment[2]. Furthermore, stabilization of TiO_2 in anatase form at high temperatures (T > 800°C) avoiding anatase-to-rutile transformation is required in applications that involves high temperature processing (e.g. self-cleaning coatings and photocatalytic ceramics). Aiming to address these issues, in this study we report preparation of thermally stable SiO_2@TiO_2 core-shell nanocomposites[3]. Such nanocomposites can be prepared by the grafting and controlled hydrolysis of titanium alkoxides on the surface of silica particles dispersed in ethanol/isopropanol mixtures. Electron microscopy analysis evidences uniform coating of SiO_2 spheres (mean size 200 nm) with a TiO_2 shell constituted of 5-7 nm titania nanocrystals. The SiO_2@TiO2 particles thermal stability was studied by *in-situ* synchroton powder X-Ray diffraction with temperature range spanning from room temperature to 1000^0C and *ex-situ* X-ray diffraction from room-temperature to 1200^0C. Both measurements prove the phase stability of the anatase up to 1200^0C, and slight size increase of the crystallite size at 1000^0C. Improvement of the photocatalytic activity of SiO_2@TiO2 is observed upon calcination between 800 and 1000^0C, while a drastic decrease in photoactivity is observed for calcined unsupported titania caused by almost complete conversion of anatase into rutile and significant loss of specific surface area. Moreover, photoactivity decrease was also observed for heat-treated SiO_2@TiO_2 samples with high TiO_2 loading (>30%) and which formation of unsupported titania particles occurred due to homogenous nucleation during sol-gel deposition, further confirming the importance of core-shell morphology for enhanced thermal stability and photocatalytic activity.

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