PHOTO-ENHANCED DEGRADATION OF METHYLENE BLUE BY TiO_2 CONTAINING ORDERED MESOPOROUS SILICA NANOPARTICLES WITH LARGE PORES AND SPHERICAL MORPHOLOGY

Gloria Zaccariello[1], Loretta Storaro[1], Elisa Moretti[1], Pietro Riello[1], Alvise Benedetti[1], Enrique Rodriguez-Castellon[2]

[1] Dipartimento di Scienze Molecolari e Nanosistemi, Università Ca' FoscariVenezia, Via Torino 155/B, 30172 Venezia, Italy
[2]Departamento de Química Inorgánica, Cristalografía y Mineralogía (Unidad Asociada al ICP-CSIC), Facultad de Ciencias, Universidad de Málaga, Campus de Teatinos, E-29071Málaga, Spain

In the recent years the sol-gel method has gained enormous interest because of its applications and future possibilities. The materials synthesized by this route exhibit very high purity, excellent homogeneity, compositions and morphology not achievable by conventional methods.
Titania is a heterogeneous semiconductor photocatalyst, which produces electron-hole pairs under ultraviolet light (200-400 nm) that initiates the formation of surface radicals capable of oxidizing adsorbed organic and biological pollutants. However, its exploitation has been restricted by a band gap energy (3.2 eV) that requires near UV wavelengths (387.5 nm) for efficient excitation and by the rapid recombination of charge carriers in the bulk. The fabrication of mesoporous nanoarchitectures is of interest as quantum yield depends on crystal size and surface morphology, in addition to absorption and diffusion of the target molecules.
The synthesis of SiO_2 containing TiO_2 composites from nanospherical ordered mesoporous silicon dioxide [1], SMNs, and titanium isopropoxide as titanium source, to obtain by sol-gel method, TiO_2/SiO_2 materials with 10 wt.%, 20 wt.%, 30% and 40 wt.% of TiO_2 is described here.
The resulting nanostructures have been investigated in detail using a variety of techniques. Typical samples of pure TiO_2, SiO_2 and their composites were characterized using N_2-physisorption (BET surface area, BJH pore size distribution and total pore volume), X-ray Diffraction (XRD), Small Angle X-ray Scattering (SAXS), Diffuse Reflectance Infrared Fourier Spectroscopy (DRIFT-IR), DRIFT and UV-Vis Spectroscopy, X-ray Photoelectron Spectroscopy (XPS), and imaged using Scanning and Transmission Electron Microscopy (SEM, TEM).
The well-defined porous structures of SMNs may offer a special environment for titania particles, offering unusual morphologies and environment thus altering the photoactivity of the materials. The UV absorptions of the nanocomposites were studied and the results discussed. The TiO_2 loading, the particle size, and the surface characteristics are shown to relate to the range and the degree of UV absorption of the composites. The results from all the techniques clearly suggest that the variation of the UV profiles is dependent on the nanostructure of the composites.
The photocatalytic activity of the nanocomposites was investigated using degradation of methylene blue (MB), a common effluent of the textile industry, as a model.
The synthesized TiO_2/SiO_2 materials appeared to be more efficient in the degradation of methylene blue, as compared to pure TiO_2 particles.

References:

[1]Ma S.; Wang Y.; Zhu Y.; J. Porous Mater., **2011,** 18, 233-239.