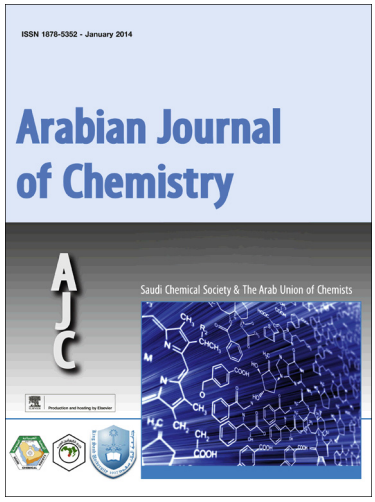

Original article

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Preparation of Silica Doped Titania Nanoparticles with Thermal Stability and Photocatalytic Properties and their Application for Leather Surface Functionalization

Carmen Gaidau[1]*, Aurora Petica[1], Madalina Ignat[1]
Laura Madalina Popescu[2*], Roxana Mioara Piticescu[2], Ioan Albert Tudor[2], Radu Robert Piticescu[2]

[1]Leather Research Department, INCDTP-Leather and Footwear Research Institute Division, 93, Ion Minulescu St, Bucharest, 3, 031215, Romania, carmen.gaidau@icpi.ro
[2]Nanostructured Materials Laboratory, National R&D Institute for Non-Ferrous and Rare Metals, INCDMNR-IMNR, 102, Biruintei Blvd., Pantelimon, Ilfov, 077145, Romania, mpopescu@imnr.ro

Abstract

Doped nanoparticles based on titanium dioxide are of interest for their multifunctional properties and enlarged photocatalytic activity in visible domain. Silica doped titanium dioxide nanoparticles were prepared by hydrothermal method and their structural characteristics and photocatalytic activity were determined, in order to be used for leather coating as alternative to halogen based flame retardants and dry cleaning solvents. A range of concentrations from 2% to 20% silica doped titanium dioxide nanoparticles (% denotes the theoretical weight percent of Si) was synthesized and characterized by ICP-OES, FT-IR, UV-Vis spectroscopy, XRD, HRTEM and DLS. Titanium dioxide network penetration was supported by Si-O-Ti and OH identification in FT-IR spectra mainly on surface of 10% and 20% silica doped titanium dioxide nanoparticles. The increase of Si-O-Ti bonds with Si dopant concentration acts as efficient barriers against sinterization and growth of TiO_2 particles and explains the low particle size identified in HRTEM analyses as compared to undoped TiO_2NPs. UV-Vis diffuse reflectance spectra of doped titanium dioxide nanoparticles showed the shifting of absorption band to visible domain for 10% silica doped titanium dioxide nanoparticles. The crystallite sizes were calculated from XRD spectra, ranging between 16.2-18.1 nm. HRTEM measurement of hydrothermally synthesized titanium dioxide nanoparticles showed anatase crystallites in the range of 8.8-27 nm, while in the 20% silica doped titanium dioxide nanoparticles sample smaller crystallite with sizes between 2.7 nm and 3.5 nm were identified due to the constraints of the SiO_2-based amorphous matrix. Nano sizes of 64 nm and 72 nm were found in water dispersions of 10% and 20% silica doped titanium dioxide nanoparticles and the Zeta potentials were of -53.6 mV and -52.9 mV, which indicates very good stabilities. The leather surface treated with composites of film forming polymers and 10% silica doped titanium dioxide nanoparticles displayed photocatalytic properties against methylene blue dye under UV and visible light exposure, attributed to reactive species generation with effect on surface hydrophilicity increase. The activation energies for decomposition of leathers treated with 10% and 20% silica doped titanium dioxide nanoparticles were 2.083×10^4 J/mol and 2.36×10^4 J/mol respectively, as compared to 6.576×10^3 J/mol for untreated leathers, showing increased thermal stability according to DSC measurements. The hydrothermal route for silica doped nanoparticles preparation proved advantages in enhancing photocatalytic properties in the visible domain and thermal resistance, with prospect for multifunctional applications.

Keywords: silica doped titanium dioxide, nanostructures, multifunctional coatings, self-cleaning properties, thermal resistant leather.

* Corresponding authors: carmen_gaidau@hotmail.com; mpopescu@imnr.ro