Nanocomposites and nanomaterials

Effect of Mn ions doping on the structure, optical and photocatalytic properties of mesoporous TiO_2 films

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Transparent, optically homogeneous mesoporous titania films modified with Mn^{2+} ions have been produced by templated sol-gel method and characterized by optical, XRD and Raman spectroscopy. Catalytic activity of prepared films have been tested in the Cr(VI) anion photoreduction. Dopant concentration was varied from 0.5 to 20 atomic%. Doping with manganese ions leads to bathochromic shift of the absorption edge and reduce the band gap from 3.3 (TiO_2), 3.0 eV (5%Mn/TiO_2) up to 2.6 eV for 20%Mn/TiO_2. Film thickness measured by ellipsometry for TiO_2 film (64 nm) increases by an average of 40-50 nm with Mn doping. The refractive index ranges from 1.87 to 1.94 (0-10%Mn), increasing the dopant concentration to 20% it increases to a value of 2.6, which can be caused by the formation of a new phase in the coverage structure, or reducing the film porosity.

The effect of metal ion doping and calcinations temperatures on anatase to rutile phase transformation has been investigated using X-ray diffraction and Raman spectroscopy. The results of X-ray diffraction and Raman spectroscopy investigation indicated the formation of anatase structure for the synthesized films after treatment at 400°C stable up to 600°C for TiO_2 and (1-5%)Mn/TiO_2 films. Increase of Mn concentration (7-20%) leads to amorphous structure formation after at 400°C that transformed to rutile at 600°C. XRD analyses showed that particles size of anatase in Mn doped TiO_2 samples calcined at 400 – 750°C were 10-14nm. Step of films crystallinity grows with the treatment temperature, but for samples doped with 0.5 -7 % Mn, anatase phase was stable up to 750 °C.

The films containing 1-5 % Mn exhibited the higher photoactivity comparing to TiO_2 one. The increase of metal content (>5 %) brought to the gradual decrease in the reaction rate constant. Synthesized covering can be used as effective photocatalysts.