Nanocomposites and nanomaterials

Iron doped TiO_2 films synthesized in N_2/CH_4 atmospheres using Pulsed Laser Deposition technique: structure and photocatalytic properties

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Iron oxide (2.5, 5 and 10 % of Fe_2O_3 or Fe_3O_4) mixed TiO_2 targets with different content of iron oxide were laser ablated to grow coatings on glass plates by PLD method. The films were synthesized at 1 mbar pressure of N_2:CH_4 atmosphere with 5:1 ratio and at substrate temperatures of 450 or 550 °C.

The films obtained in N_2/CH_4 at both 450 and 550 °C are predominantly amorphous as shown by XRD investigation. However, a low intensity rutile peak is noticeable for the only 10% Fe_3O_4/TiO_2 obtained at 550 °C. For comparison, the films obtained in O_2 exhibited the crystalline structure: Fe_2O_3/TiO_2 are poorly crystalline with a highly disordered anatase phase comparing with the Fe_3O_4/TiO_2 films where the diffraction peaks of anatase and rutile are well-defined and the higher Fe_3O_4 content led to the higher crystallization degree. It is concluded that the films obtained in N_2/CH_4 are amorphous due to the deficiency of oxygen that occurs during synthesis procedure and nitrogen incorporation into the film structure.

SEM images showed the porous grainy like surface. The iron content accumulated onto the film surface is calculated from EDS data.

The predicted red shift in absorption onset is observed for the all films obtained N_2:CH_4 comparing with the ones synthesized in O_2. The most intensive absorption is obvious for the films contained of 5% iron oxide obtained in N_2:CH_4 and at 550 єC. A significant decrease in the band gap energy is noted for the samples treated at higher temperature. Independing on the iron oxide source, two band gap values can be calculated by extrapolating the linear parts of the $(\alpha h\upsilon)^{1/2} \sim f(h\upsilon)$ curves only for the films contained 2.5 and 5 % of iron oxide (550 єC) and a single band gap energy is obtained at higher iron oxide content.

Photocatalytic activity of the films was assessed via dichromate ions reduction reaction. Under visible light irradiation, the photocatalytic activity is increased in 2-3 times for the films treated at 550 єC comparing to 450 єC. The films with lower iron content exhibited the better activity. When *UV irradiation* was applied, the catalytic performance of the films treated at higher temperature was noticeble higher with the highest efficiency (about 70 %) for 10 % Fe_3O_4/TiO_2. The influence of iron source is pronounced for both cases where the films obtained using Fe_3O_4 showed better photocatalytic properties.