# Optical, Structural and Photocatalytic Characteristics of Iron-Doped Titania Films Synthesized by Sol-Gel Method

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Sol-gel technology is a well-regulated technique to obtain the nanostructured systems and allows the homogeneous distribution of the components on the atomic level. The synthesis of sol-gel doped $TiO_2$ films requires the special approaches depending on the stated goal such as i) an incorporation of dopant ions into $TiO_2$ crystal lattice; ii) solid solution formation ($Ti_{1-x}Zr_xO_2$) or iii) spinel phase formation ($Ti_xX_yO_z$) [1]. It known that $TiO_2$ absorbs only 4% of ultraviolet light and it is inert in the whole visible range of the solar spectrum. The challenge is therefore to extend the sensitivity of $TiO_2$ towards the visible range of the spectrum. Our work presents the correlation of the synthesis conditions with optical and structural peculiarities as well as the photocatalytic properties of iron doped titania films.

The non-porous films are prepared by sol-gel method using titanium tetraisopropoxide and unhydrous iron(III) chloride. The films were deposited by a dip-coating technique with the withdrawal rate of 1.5 mm/s. The films are thermal treated at 450 and 600 °C. The significant shift in the optical absorption edge to the visible part of absorption spectra is observed for $Fe^{3+}/TiO_2$ films comparing with bare titania. A change in the band-gap calculated by extrapolating the linear parts of the $(\alpha h\nu)^{1/2} \sim f(h\nu)$ curves (the indirect electronic transition) corresponds to 2.2 eV for films at 450 °C and two values: 1.9 and 2.2 eV for the films at 600 °C. XRD results show that the treatment temperatures influence on the phase composition of the films. No anatase, but only pseudobrookite ($Fe_2TiO_5$) structure is registered for the doped films treated at lower temperature while the film structure (600 °C) contains the numerous phases (rutile, $Fe_2TiO_5$, $Fe_2Ti_2O_7$ and $Fe_2O_3$). Photocatalytic activity was studied in the processes of toxic dichromate ions reduction and tetracycline hydrochloride (TC) degradation. Activity of the films (450 °C) is increased 3-4 times during TC degradation and more than three times during dichromate ions reduction under both UV and visible light in comparison with the $Fe^{3+}/TiO_2$ films (600 °C) and bare $TiO_2$ films. Thus, the certain phase composition of the doped semiconductive films is responsible for a more efficient separation of photogenerated electron-hole pair that led to improvement of the photoactivity.

1. Nataliia Smirnova, Yuriy Gnatyuk, Nadiia Vityuk, Oksana Linnik, Anna Eremenko, Vera Vorobets, Gennadiy Kolbasov // Nanosized $TiO_2$ - Based Mixed Oxide Films: Sol-gel Synthesis, Structure, Electrochemical Characteristics and Photocatalytic Activity // International Journal of Materials Engineering 2013, 3(6): 124-135.