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Thin films of titanium dioxide (TiO_2) have attracted considerable attention in the past few years, since nanocrystalline TiO_2 shows outstanding properties (high photocatalytic activity, chemical stability, strong oxidation activity and non-toxicity) and has widespread application potential (self-cleaning surfaces, solar cells and energy conversion systems, gas and UV sensors, battery systems, etc.). All these applications rely on the semiconducting property of the TiO_2, which is only found in crystalline TiO_2. Crystalline TiO_2 has three natural crystalline modifications (named anatase, rutil and brookit), which differ in their semiconducting characteristics [1].

Method of preparation of crystalline TiO_2 thin films crucially affects their structural and microstructural properties influencing the TiO_2 (photo)catalytic performance. Since during commonly used method for the preparation of pure and crystalline TiO_2 thin films, calcination, an excessive sintration, crystallite growth or recrystallization occurs, this thermal processing is combined by supercritical carbon dioxide ($scCO_2$) drying in last years. It was found that the pre-treatment of sol-gel derived metal oxide thin films as well as powders using supercritical carbon dioxide helps to enlarge surface area significantly and improve electronic properties showing enhanced photocatalytic performance [2].

To reduce the process temperature and to increase the thermal stability and the photocatalytic activity the TiO_2 thin films can be also directly crystallized by using $scCO_2$, subcritical water, pressurized organic solvents or their combination in consecutive steps, as discussed recently [3, 4].

In this work, the $scCO_2$ modified by mixture of water and ethanol was used for a preparation of crystalline and pure nanostructured TiO_2 thin films in one step processing. All the experiments were performed over precursor titania thin films prepared by reverse micelles assisted sol-gel method, using hardly removable nonionic surfactant Triton X-114, however, forming uniform nano-domains. The effect of temperature (40-150 °C), pressure (10-30 MPa), modifier composition (20, 50 and 80 % w/w of water in ethanol) and concentration in $scCO_2$ (5-15 wt. %) and consumed amount of solvent (50-200 g) on microstructure and purity of TiO_2 thin films was thoroughly studied by means of Raman spectroscopy, X-ray diffraction, and contact angle measurements.

Anatase structure occurred in all tested TiO_2 thin films except those prepared at low temperature of 40 °C. When the processing was performed at lower temperatures than 100 °C, pressure bellow 20 MPa and solvent amount lower than 100 g the larger amount of surfactant residue in TiO_2 thin films was observed. The crystalline structure of anatase, which size changed from 1.2 to 7 nm in dependence on experimental conditions, was obtained without necessity of any additional thermal treatment of TiO_2 thin films. When $scCO_2$ modifier contained 80 % w/w of water the partial elution of TiO_2 film from glass substrate was observed.

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