High-Photocatalytic Performance of TiO_2, TiO_2-SnO_2 Thin Film from its Precursor Solution by New Sol-gel Method

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INTRODUCTION:

Recently, we reported the preparation of TiO_2 precursor solution and its thin film by a new solution method[1)] which is different from the conventional sol-gel method[2)]. This process is based on the hydrolysis and polymerization of metal alkoxide in hydrophilic and hydrophobic mixed solvents such as butanol and toluene This method was named the *advanced sol-gel metho*d, ASG, and has the advantage of having a crystallization temperature of 360°C, which is somewhat lower than that of the conventional sol-gel method [2)].

The aim of this study is to analyze the photocatalytic improvement by addition of TiO_2 film to SnO_2. And the film's structure, transparency, etc. are also studied.

EXPERIMENTAL:

Titanium tetra n-butoxide (monomer) was used as the starting material. The titanium alkoxide was dissolved in a mixed solvent of butanol and toluene. After the addition of a small amount of H_2O dissolved in butanol, the mixed solution was refluxed, concentrated and diluted with solvent. Tin oxide precursor solution was prepared in the same manner. The thin films were prepared on quartz or glass substrates by spin-coating. The light transmission and/or absorption spectra were measured. Characterization of films was determined by TG-DTA, X-ray diffraction analysis, atomic force microscopy, and UV-vis measurement. Also, the photocatalytic activity of TiO_2 and TiO_2-SnO_2 thin film prepared by this method is investigated with carbon decomposition reaction.

RESULTS:

TiO_2 films having anatase structure (Fig.1-b), mixing of anatase and rutile one (Fig.1-b) and rutile structure (Fig.1-c) showed good transparency. SnO_2 and TiO_2-SnO_2 films (in Fig.2) mixing the precursor solution of TiO_2 and SnO_2, various binary oxide films are easily made. In Fig.3, X-ray patterns of several composition films after being annealed at 500°C are shown. SnO_2 and TiO_2 films showed rutile and anatase structures, respectively. By mixing two components and annealing at the same temperature, rutile type structures appeared, though rutile structures of TiO_2 usually appeared at about 700°C. The absorption edge is shifted to a longer wavelength by adding SnO_2 to TiO_2 (Fig.2). Photocatalytic ability measured by decomposition of India ink is shown in Fig.4. By adding SnO_2 to TiO_2, photodecomposition of India ink under the irradiation of lamp is increased. This figure shows irradiation filtered to cut UV rays.

REFERENCES:

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2)J. Livage, Mat. Res. Soc. Symp. Proc.,**73** 717(1986); D. Kundu and D. Ganguli, *J. Mater. Sci. Lett.*, **5** 293 (1986).

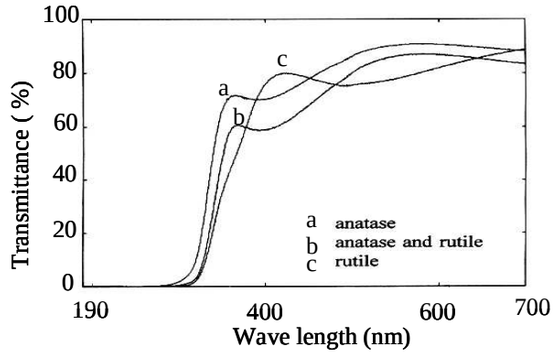

Fig.1. Transparency of the anatase, rutile and mixed TiO_2 thin films.

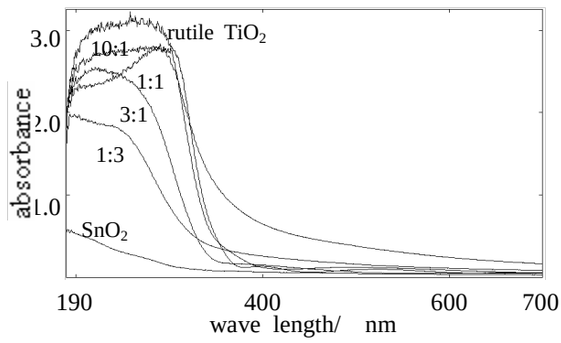

Fig.2 UV-vis Spectra of thin films prepared from various compositions of TiO_2- SnO_2 ratio precursor solution.

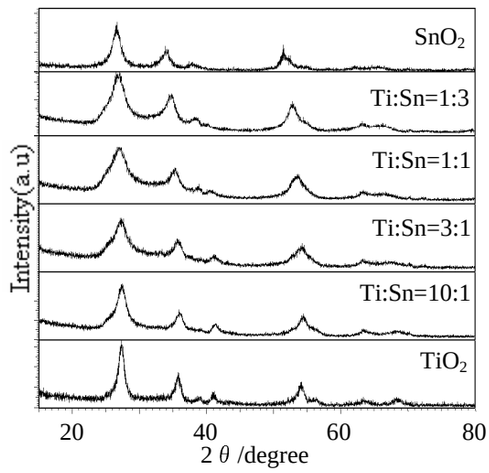

Fig.3 X-ray diffraction patterns of TiO_2-SnO_2 thin films prepared from each precursor solution.

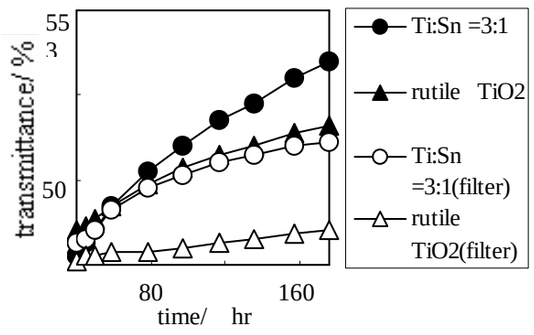

Fig.4 Transmittance of thin films coated with India ink and irradiated by fluorescent lamp.