Preparation of TiO_2 Thin Film by Plasma CVD

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Exhaustion of petroleum resources and environmental pollution such as global warming by mass consumption of the fossil fuels become a serious problem. The sun radiates enormous energies on the earth. This is 10,000 times larger than the total amount of energies which we the human beings consume in one year[1]. The solar energy is inexhaustible and don't cause the environmental pollution. Then the various researches concerning the effective utilization of solar energy have been progressed. Titanium dioxide photocatalyst has the possibility of converting solar energy into the conventional energy which we can use by applying it to dye-sensitized solar cell or hydrogen generation by water splitting[2]. It also has the ability of decomposing environmental pollutants such as NOx, SOx and endocrine disrupters. The titanium dioxide has been applying various goods since its ability as above and another important feature of super hydrophilicity. However, titanium dioxide photocatalyst can't absorb the light of the wavelength over 400nm since its bandgap of 3.2eV. It is necessary to develop the photocatalyst which can absorb the light of the wavelength over 400nm in order to effective use of solar light since sunlight has only about 3% ultraviolet rays. Various methods including introducing oxygen defects and partially nitrization have been tried to develop visible light response on the photocatalyst[3]. In this study, the investigation was made for the purpose of developing the ability of visible light absorption of titanium dioxide thin films which prepared by using plasma CVD. The synthesized TiO_2 thin film was evaluated by SEM, X-ray diffraction, UV-Vis absorption and an efficiency test as a photocatalyst.

Schematic diagram of the Plasma-CVD system, Samco International Inc. PD-2S, used in this study is shown in Fig.1. Glass slides for optical microscope were used for substrates. Titanium isopropoxide (TITP) and oxygen gas were used as raw materials. Fig.2 shows the SEM images of the surface and the cross section of the thin film deposited at 723K for 4h. The film was transparent and not damaged by scratching with nails. X-ray diffraction result, Fig.3, shows the film is anatase. Reduction processing was performed to the film in the plasma which generated by H_2 gas. The increase of the amount of absorption of visible light was observed after the reduction process (see Fig.4).

References
1) Y. Adachi "New Energy Technology", Ohmsha Japan, p27(1997).
2) T. Takata et al., Catalysys Today 44, 17(1998).
3) A. Kasahara et al., J. Phys. Chem. A, 106, 6750(2002).

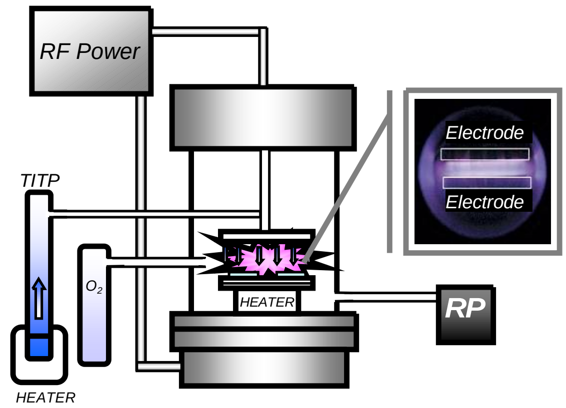
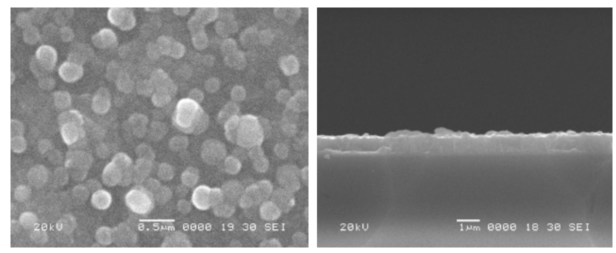


Fig.1 Schematic diagram of the plasma-CVD system.



(a) (b)

Fig.2 SEM images of (a) the Surface and (b) the cross section of TiO_2 thin film prepared at 723K for 4h.

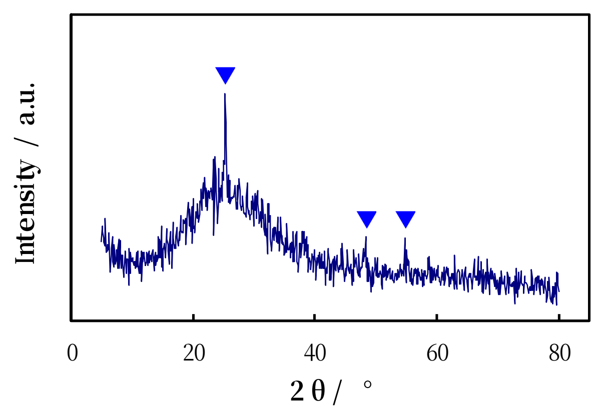


Fig.3 X-ray diffraction spectrum of the TiO_2 film deposited at 723K for 4h. Triangles show the peaks attributed to anatase.

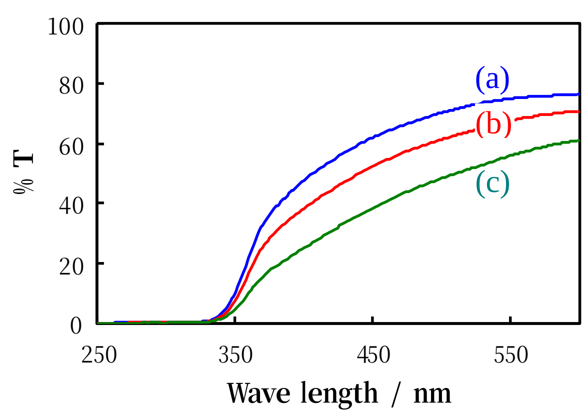


Fig.4 UV spectra of the TiO_2 films (a) as deposited at 723K for 4h, (b) after treatment in hydrogen plasma at 723K for 10h and (c) 30h.