Irradiation on photo catalytic TiO_2 thin films for biological applications

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Photocatalytic hydrogen production using suspended photo catalysts were studied. TiO_2 anatase in a powder form was used as photo catalyst. Our investigation aims to wards the creation of improved photo catalysts to be used in the production of hydrogen from water or aqueous solutions of organic compounds. TiO_2 anatase in a powder form was used originally as photo catalyst. It was found that the photocatalytic activity depends significantly on catalyst type and its modification such as loading with various transition metal oxides. In photocatalysis, light irradiation of TiO_2 powder with photon energy larger than the band-gap energy produces electrons (*e*−) and holes (*h*+) in the conduction band and the valence band, respectively. These electrons and holes are thought to have the respective abilities to reduce and oxidize chemical species adsorbed on the surface of TiO_2 particles. In most photocatalytic reactions, oxidation processes are utilized for a variety of purposes, and the reduction of molecular oxygen is often used as a counter reaction. Hence, in the field of photocatalysis, most of the research interest has been focused on oxidation processes. Pure and doped thin films of TiO_2 will be prepared. Nano structure in thin films of pure and doped TiO_2 will be introduced by SHI irradiation. Desired modification can be achieved by tailoring it with SHI irradiation of Ag or Li with energies around 100-200MeV. We will study the structure, surface morphology and dielectric properties and resistivity and thermo dynamical properties of these films. Various schemes to accomplish visible light photo catalysis will be described along with the general synthesis issues, characterizations, and applications. One of the most exciting recent discoveries is the effect of irradiation on TiO_2 were improve the optical reactivity of TiO_2 in the visible region.

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1. TiO_2 film preparation

As described elsewhere, for the preparation of the PEG containing TiO_2 films, titanium tetra-*n*-butoxide (TTB) was used as the starting material (1). TTB was first mixed with a small amount of ethanol (EtOH) after which a mixture of water, HCl was poured while stirring into the transparent solution to promote hydrolysis (2). Finally, an organic polymer (PEG) was added slowly to this mixture, and the resulting solution was used for the TiO_2 film coating (3). The sol–gel solutions were prepared in the presence of PEG of different molecular weights (200, 400 and 600); the molar ratio of PEG to TTB was one. TiO_2 thin films were deposited onto SL glass and quartz substrates by dipping: the substrate was lowered into the coating solution and then withdrawn at a regulated speed of 4 mm/s(4). In some cases, a second dipping increased the thickness of the films (5). After each coating, the films were crystallized by a hot water treatment at a temperature of 90ºC for 1 h. thereafter; some films were annealed at 900ºC temperature (6).

2. TiO_2 film characterization

Powder X-ray diffraction studies were carried out for the as grown crystals using Rich Seifert X-ray diffractometer with CuKα (λ= 1.5498 Å) radiation.

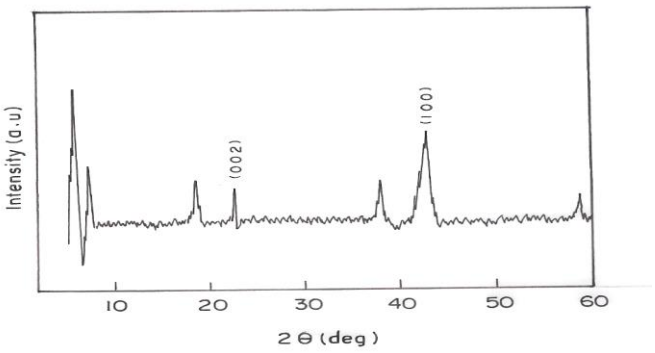

Fig. 2. XRD of Irradiated TiO_2.

Fig. 1 shows the XRD data of the TiO_2 film prepared in presence of PEG 200. The samples evolve in identical ways upon heating. The as-deposited films are amorphous and scatter X-rays below 5 nm^{-1}, as well as between 11 and 18 nm^{-1}. Treatment in water eliminates most of the diffuse scattering, and leads to nanoscale anatase crystals (7). Annealing after treatment in hot water leads to a sharper anatase (1 0 1) peak at 17.85 nm^{-1}.

Pos. [°2Th.]	Height [cts]	FWHM [°2Th.]	d-spacing [Å]	Rel. Int. [%]
20.9834	935.72	0.2175	4.23375	79.19
23.4066	1181.62	0.1673	3.80065	100.00
25.6530	395.44	0.2007	3.47270	33.47
28.6375	582.86	0.2007	3.11721	49.33
29.0765	627.70	0.2342	3.07114	53.12
30.4263	217.00	0.2007	2.93790	18.36
31.5088	288.49	0.2342	2.83940	24.41
32.8486	52.97	0.3346	2.72658	4.48
35.6341	228.87	0.2007	2.51958	19.37
36.4683	223.60	0.2342	2.46384	18.92
39.2303	26.82	0.8029	2.29650	2.27
41.9753	47.78	0.2676	2.15245	4.04
44.6822	66.73	0.3346	2.02814	5.65
47.3648	55.59	0.5353	1.91935	4.70
48.8721	124.26	0.1673	1.86362	10.52
50.0712	64.28	0.2676	1.82177	5.44
51.5623	56.36	0.9792	1.77107	4.77

The anatase (2 0 0) peak at 33.21 nm^{-1} is the second prominent peak of this phase. After treatment in hot water at 90ºC, the crystallite size is 5 nm for samples prepared with PEG 200. Upon annealing at 500ºC, the crystallite size increases to 6, 8 and 10 nm for the films prepared with PEG 200.

3. Effect of Irradiation on TiO_2 thin film

Ion irradiation offers a unique way to investigate defect structures of TiO_2 and their influences on TiO2 various properties (8). The amount of defects created in the TiO_2 was correlated with the nuclear and electronic energy loss of ion beams (9). Ion irradiation introduces a wide range of defects in a controlled manner and is used to tailor material properties. The irradiation-mediated improvements in thermal stability of TiO_2 under a few Li and Ag ions (10). The predominant methods to deliver drugs are oral and injection, which has limited the progress of drug development (11)t. Market forces are also driving the need for new, effective drug delivery Methods. It is estimated that biological uses will be account for 49% of all pharmaceutical sales by 2011(12). Meanwhile, upcoming patent expirations are driving pharmaceutical companies to reformulate their products. New methods may enable pharmaceutical companies to develop new formulations of off patent and soon-to-be off patent drugs.

4. Conclusion

Titanium dioxide (TiO_2) is a widely investigated material for its biological compatibility, high dielectric constant and refractive index, chemical and mechanical resistance, and catalytic activity. Several different techniques are available to produce TiO_2 thin films, which are variously suited to provide the properties required for a specific application. Dense TiO_2 coatings with high refractive index and low optical absorption are aimed at for optical applications. High thickness uniformity on large area coatings and a high, precisely controlled, growth rate are further advantages. In this project photocatalytic coatings are prepared by sol-gel method.

Additionally, analytical testing methods and devices will be developed, and biological and environmental aspects of photocatalysis will be investigated. In addition, irradiation of higher doses of Li^+ ion damages the lattice effectively and the crystalline quality of the irradiated region. Based on a number of pertinent control experiments it is possible to conclude that the overall nanoscale drug system is more selective and effective than the free drug and it should result in reduced general toxicity and hence reduced side effects in patients and also allows a lower amount of the drug to be applied.

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