V-B Nano-Structure in Metal Oxides Prepared by Synchrotron Radiation and Swift Heavy Ions

In the project, micro-nano fabrication technique for metal oxide has been examined. The first one is the deep x-ray lithography and the liquid phase deposition method. Periodic arrangements of titanium dioxide (TiO_2) micro structure projections were fabricated in a supersaturated aqueous solution using ordered microcavities of poly (methylmethacrylate) as a template. The shape and periodicity of the TiO_2 projections were strictly controlled with the depth and arrangement of the cavities because crystalline TiO_2 was uniformly grown on the organic surface through heterogeneous nucleation. This biomimetic route is applicable to designed synthesis of three-dimensional architectures for photonic structures of various metal oxides. The other method is by using of the latent tracks introduced by the swift heavy ion. Micro structure having nano-order flatness was achieved after chemical etching. This method can be applied to create photonic crystal structure of titanium dioxide.

V-B-1 Photoinduced Hydroxylation at ZnO Surface

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We observed UV-stimulated hydroxylation at the surface of ZnO crystals. Reactive defective sites were initially formed in the surface layer via photoreduction induced with energetic photons above the band gap of ZnO. Hydroxyl groups were produced by a chemical reaction of the photoinduced defective sites with water molecules in the atmosphere. Two types of hydroxyl groups were found at the irradiated surface because two kinds of defective sites were induced with the UV illumination.

V-B-2 Ablation and Compaction of Amorphous SiO_2 Irradiated with ArF Excimer Laser

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The structure of amorphous SiO_2 exposed to ArF excimer laser irradiation was examined. Threshold fluence for causing ablation with a single pulse depended on sample preparation: more specifically, 1 J/cm^2 for thermally grown SiO_2 films on silicon and 2.5 J/cm^2 for bulk SiO_2. It was found that the bond angle of Si–O–Si was reduced by irradiation near the interface of thermally grown SiO_2 films. In contrast, evolution of the bond angle by irradiation was absent in both the bulk SiO_2 and SiO_2 film-near the top surface, even though the concentration of puckered four-menmered rings deduced from Raman spectra dramatically increased. It is assumed that planar three-membered rings were generated in the SiO_2 thin layer near the interface, and puckered four-membered rings were generated in the bulk SiO_2. The concentration of both the Si^{3+} and Si^{2+} structure was increased at a fluence of 800 mJ/cm^2 with an increasing number of pulses, although generation of both was absent at higher fluence for a single pulse. The author proposes that the structure of SiO_2 is created by flash heating and quenching by pulse laser irradiation. Structural similarities were found between the irradiated SiO_2 and SiO_2 at high temperatures.