Surface Potential and Hydrophilicity Measurements on Titanium Dioxide before and after Ultraviolet Irradiation

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Surface properties of titanium dioxide (TiO_2) have been studied extensively due to their attractive phenomena such as photocatalysis and photo-induced superhydrophilicity. However, relations between these phenomena and photo-induced carriers in TiO_2 have not been fully understood yet. In this work, we discuss the relationship between surface potential (SP) and hydrophilicity on various TiO_2 surfaces before and after ultraviolet (UV) irradiation, by investigating the relaxation process of SP with Kelvin probe force microscopy (KFM) and water contact angle measured with an inkjet deposition system.

Anatase nanoparticle thin film deposited on a glass substrate and single crystalline sheets of rutile (110) and (001) were used for our measurements. A 30-nm-thick gold film as reference electrode was deposited onto a part of each TiO_2 sample by vacuum evaporation. Amplitude-modulation, lift-mode KFM was utilized for SP measurements (Fig. 1). The relaxations of SP and water contact angle after UV irradiation (300-400 nm, 5 mW/cm^2) were examined in the dark under ambient condition.

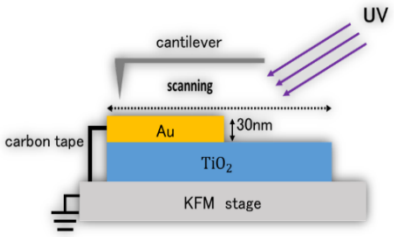

Fig. 1 Setup for KFM measurement.

Figure 2 shows time variations of SP and water contact angle measured for the nanoparticle thin film. After the UV irradiation was removed, both parameters decayed gradually in the same time scale of several hundred seconds. Similar phenomenon was also observed for rutile (110) sheet, but in the time scale which was four to five times longer than that of the nanoparticle thin film. Some correlation between the relaxation of the surface potential and water contact angle can be expected and these phenomena may reflect trapping behaviors of photo-induced holes on TiO_2 surfaces, as discussed in a previous report on hydrophilicity controlled by anodic polarization [1].

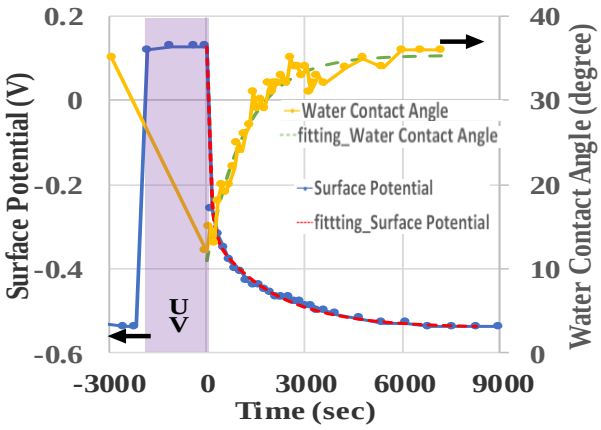

Fig. 2 Surface potential and water contact angle measured for TiO_2 nanoparticle thin film.

[1] K. Hashimoto et al., J. Phys. Chem. B **105**, 3023 (2001).

Supplementary Pages

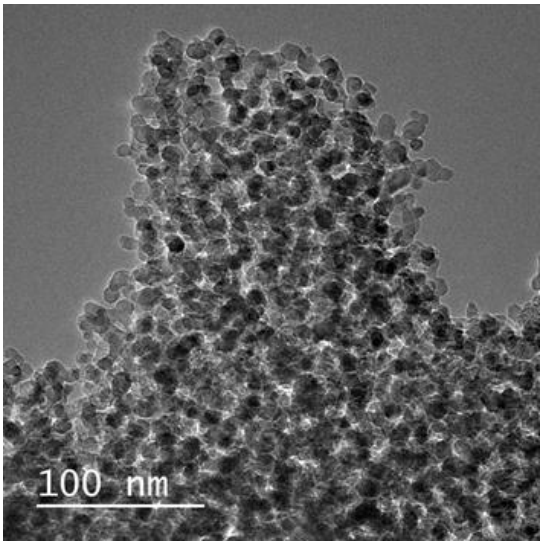

Fig. S1 Transmission electron microscope (TEM) image for TiO_2 nanoparticle thin film prepared with our sol-gel method.

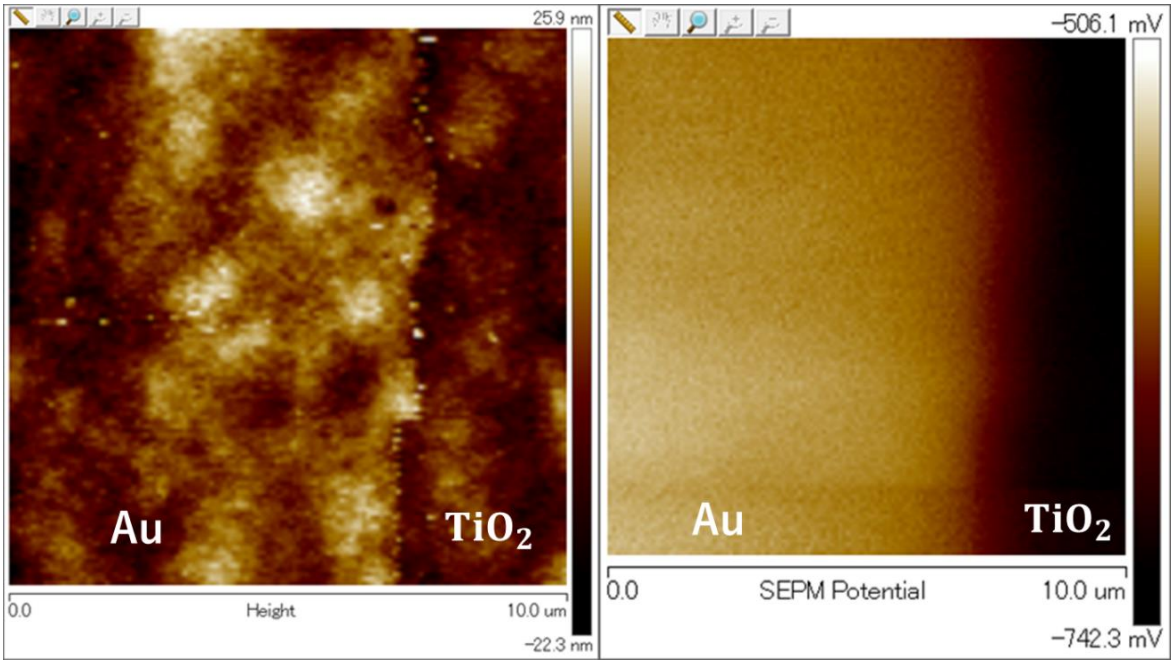

Fig. S2 (Left) Topography and (Right) surface potential images simultaneously observed for TiO_2 nanoparticle thin film. In these images, the left-hand side of the observed area was covered with Au electrode.