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Structural change of the TiO2(110) surface in the hydrophilic reaction

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Photocatalysis of titanium dioxides has been extensively studied in the past. Especially, after the discovery of the UV-light induced hydrophobic-hydrophilic transition of the rutile-TiO2(110) surface in the late of 1990's [1], the number of photochemistry-related publications increased dramatically over the last decade to the extent that ~2400 related papers were published in 2008, in which ~80% of the papers involve the TiO2-related materials. The remarkable research activity arises from the potential applications of the photo-induced wettability control such as anti-fog coatings or self-cleaning coatings. However, despite the intensive study, the mechanism of the hydrophilic reaction is not completely clarified yet, mainly due to the lack of the detailed information of the atomic-scale surface structure. We have studied the surface structural change by means of surface X-ray diffraction. By using the recently developed time-resolved x-ray crystal truncation rod (CTR) scattering measurement [2] and the static measurement for the hydrophobic and hydrophilic surfaces, we confirmed that (i) the surface roughness increases during the reaction probably due to the desorption of the surface oxygen atoms and (ii) an ordered water molecular layer formed on the hydrophobic surface disappears in the hydrophilic surface. Considering the previous reports which show the increase of hydrogen bond density in the hydrophilic surface, we suggest that the ill-ordered surface of the hydrophilic phase allows a larger number of water molecules to adsorb by making a hydrogen-bond network.

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