Quenching of oxygen photodesorption from TiO$_2$(110) through co-adsorption

NIKOLAY PETRIK, GREG KIMMEL, MINGMIN SHEN$^1$, MICHAEL HENDERSON, Pacific Northwest National Laboratory — Fundamental understanding of photochemical reactions on TiO$_2$ surfaces is important for many practical applications. We used temperature programmed desorption and photon stimulated desorption (PSD) to show that coadsorbates of varying binding energies (Ar, Kr, Xe, N$_2$, CO, CO$_2$, CH$_4$, N$_2$O, acetone, methanol or water) on the rutile TiO$_2$(110) surface suppress the hole-mediated photodesorption of adsorbed O$_2$. The extent of suppression correlates with the coadsorbates gas phase basicity, which in turn determines the strength of the coadsorbate-Ti$^{4+}$ bond. Coadsorbed rare gases inhibited the photodesorption of O$_2$ by 10-25%, whereas strongly bound species (water, methanol and acetone) nearly completely inhibited O$_2$ PSD. We suggest that coadsorption of these molecules inhibit the arrival probability of holes to the surface. Band bending effects, which vary with the extent of charge transfer between the coadsorbate and the TiO$_2$(110) surface, are not expected to be significant in the cases of the rare gases and physisorbed species. These results indicate that neutral coadsorbates can influence significantly the charge transfer events by altering the interfacial dipole in the vicinity of the target molecule.

$^1$Current address: Rive Technology, 1 Deer Park Drive, Suite A, Monmouth Junction, NJ 08852

Greg Kimmel
Pacific Northwest National Laboratory

Date submitted: 10 Nov 2016

Electronic form version 1.4