Reduction of TiO_2 by a low-temperature degradation of adsorbed organic solvents

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We discuss how employing a refluxing solvothermal treatment of TiO_2 in organic solvents at mild temperature (120 °C) allows producing blue-colored and reduced titanium dioxide (TiO_{2-x}). The treatment, tested for different organic solvents, increases the density of Ti(III) species and the appearance of two optical absorption features: a broad absorption band responsible for the blue coloration and a subgap absorption tail close to the band gap energy.

Experimental analyses based on X-ray photoemission spectroscopy and excitation-resolved photoluminescence suggests that the solvothermal process at 120°C leads to formation of surface and subsurface oxygen vacancies (V_O). Different solvents have been tested, where ethanol is found to be the most effective. Improved photocatalytic degradation by the processed TiO_2 under VIS illumination is demonstrated, and the possible mechanism involved in the formation of surface V_O is discussed. The method outlines a very simple, low-cost, and fast procedure to target the formation of V_O in the TiO_2 surface region.

Figure 1: Image P25 powder before (left column) and immediately after (center and right columns) a 24 hours refluxing treatment in three different alcohols (Top row: ethanol; center row: methanol; bottom row: 2-propanol) and at two different oil bath temperatures: T1=Tb+10°C (center column) and T2= 120°C. Here Tb indicates the boiling temperature of the different alcohols.