Doping of TiO_2 for Improving its Photochemical Activity

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Titanium dioxide has emerged as the celebrated material for numerous applications, among which the photocatalysis is one of the most studied. TiO_2 is a wide band-gap energy (>3.0 eV) semiconductor, therefore, only UV light (< 400 nm) can be utilized for generation of electron-hole pairs in its pristine form(s). On the other hand, there are also evidences that, defects created within the band-gap, either on purpose or through the preparation routes, lead to remarkable photochemical activities. Numerous physical (vapor and/or sputter deposition, etc.) and wet-chemical (sol-gel, and/or layered deposition, etc.) routes have been heavily investigated to create materials with controlled defects, which can simply be categorized as n- or p-doping processes. Similarly, there has also been an immense activity for reliable characterization of the resultant materials, using electrical, electrochemical, and/or spectroscopic tools. In this contribution, a brief review of the preparation routes, and characterization techniques will be given with a special emphasis on the use of X-Ray Photoelectron Spectroscopy, XPS, for harvesting chemical and electrical properties of various doped TiO_2, and similar materials, by utilizing electrical and/or optical modulation techniques.