Solution-processible reduced TiO_2 nanomaterials at room temperature and their applications

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Recently, an energy bandgap reduction of TiO_2 nanomaetrials, referred to as black TiO_2, which can absorb both visible and near-infrared solar light, has triggered an explosion of interest in many important applications. Here, we like to report a selective reduction of commercialized Degussa P-25 TiO_2 nanoparticles ($rTiO_2$) using simple room-temperature solution processing, which maintains the unique three-phase interfaces composed of ordered white-anatase and disordered black-rutile with open structures for easy electrolyte access. The strong reducing agent in superbase, which consists of lithium in ethylenediamine, can disorder only the white-rutile phase of P-25. Single P-25 TiO_2 nanoparticles with this engineered surface made immediate contact with the electrolyte. This contact is called white-black-electrolyte three-phase interfaces and can not only efficiently internally separate electrons/holes through type-II bandgap alignment but also induce a strong hydrogen (H_2) evolution surface reaction. The white-black-electrolyte three-phase interfaces exhibited outstanding H_2 production rates.[1] In addition, we also found that the $rTiO_2$ effectively generated reactive oxygen species (ROS) in solar light and removed a bloom of algae. The ROS generation from $rTiO_2$ was confirmed by electron spin resonance with UV and solar light, respectively, and effectively removed algae, *Chlamydomonas*, which causes negative effects to environment when accumulated in aquatic ecosystem under solar light atmosphere.[2]

References

1. Kan Zhang, et. Al., "Three-phase Interfaces of Titanium Dioxide Nanoparticle-Water for Highly Efficient Co-Catalyst-Free Photocatalytic Hydrogen Generation", Energy & Environmental Science, DOI: 10.1039/C5EE03100A, 2015.

2. Youngmin Kim, et al., “Solar-light disinfection of algae using solution-processible TiO2 reduced at room temperature”, Submitted, 2015.