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# Nanostructured $TiO_2$ with oxygen vacancies for the decomposition of organics

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## Abstract

Titanium dioxide ($TiO_2$) has been widely not only studied but also applied in industrial fields as photocatalyst because of its environmentally and economically advantages with high chemical stability, earth abundant and bio compatible properties. However, its large band-gap for the activity to only UV light region, and the high recombination rate of photogenerated electron and hole pairs have to be overcome to utilize effectively sunlight and to enhance the photocatalytic performance. Recent enormous efforts to overcome the above-mentioned drawbacks have resulted in the one-dimensional $TiO_2$ nanotubes, nanofibers and nanorods to suppress the carrier recombination, and/or the heterojunction structure of $TiO_2$ with another semiconductor to achieve larger separation of the photogenerated electron and hole, as well as the modification of $TiO_2$ nanoparticles with gold clusters to expand the light conversion from UV to visible and near-infrared region. Here, we report simple and effective modification of nano-sized $TiO_2$ materials by in-liquid plasma processing, which is a non-thermal plasma discharged in liquid. The present study focused to treat pristine $TiO_2$ nanoparticles by the discharge in water-based solution and to investigate the material properties as well as the photocatalytic activities for decomposing organics. As a result of plasma treatment, we found the incorporation of oxygen vacancies on the sub-surface of $TiO_2$ nanoparticles, and concluded that the origin of photocatalytic enhancement for acetaldehyde decomposition under fluorescent lamp attributed in the recombination suppression by the surface trap of oxygen vacancies near the nanoparticles surface.

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