# Increase and Enrichment of Active Electrons by Carbon Dots Induced to Improve $TiO_2$ Photocatalytic Hydrogen Production Activity

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**Abstract**

Recombination of photogenerated carriers severely reduces the efficiency of photocatalytic reactions. Herein, Bio-CDs/$TiO_2$ were produced using the hydrothermal method to tightly load biomass-based carbon dots (Bio-CDs) onto the surface of $TiO_2$ *via* Ti-O-C bonds. Finite-difference time-domain (FDTD) simulations showed that the Bio-CDs act as electron storage pools in the Bio-CDs/$TiO_2$, enhancing optical absorption and promoting the transfer and storage of photogenerated electrons from $TiO_2$ to the Bio-CDs, and thus effectively inhibiting the recombination of electron-hole pairs. Photocatalytic hydrogen production by the Bio-CDs/$TiO_2$ was significantly improved compared with that by pristine $TiO_2$ (603.92 μmol $h^{-1}$ $g^{-1}$ *vs* 94.18 μmol $h^{-1}$ $g^{-1}$) and, importantly, the Bio-CDs/$TiO_2$ performed well over several cycles. Surprisingly, Bio-CDs/$TiO_2$ also exhibits nice catalytic performance for hydrogen production under the combined action of photoelectricity, and its Tafel slope was significantly lower than that of pristine $TiO_2$, which confirmed that the same research potential of Bio-CDs/$TiO_2$ in the field of photoelectrocatalysis. This work introduces new ways to study the synergistic effects of multiple mechanisms (enhanced optical absorption, increased separation of photogenerated carriers and promotion of transfer and storage of photogenerated electrons) in the enhancement of photocatalytic and photoelectrocatalysis activity of semiconductors by carbon dots.

**Keywords**: Biomass-based carbon dots; $TiO_2$ composite; light absorption enhancement; electrons harvest; $H_2$ generation.