Surface imaging of charge transfer on photocatalysts

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Photoinduced charge transfer across nanometer to micrometer scales, with varied lifetime, is at the heart of solar fuels-conversion catalysts. Advancing these catalysts towards high photo-to-chemical conversion efficiency requires a spatial understanding of the photogenerated charge separation and transfer process.

In recent years we have developed and used AFM based surface photovoltage (SPV) microscopy to gain new insight into these processes. In particular, we have been able to reveal the role of the built-in electric field in surface charge recombinatino in the anisotropic photoinduced charge transfer in a single crystal $BiVO_4$ photocatalyst. Probing the local separation of photogenerated charge carriers across co-catalyst loaded photocatalyst particles we found that co-catalyst has a conclusive effect on charge separation in photocatalyst particle by aligning the vectors of built-in electric fields in the photocatalyst particle. This effect is beyond its catalytic function in thermal catalysis. We proposed a new strategy with Dember effect assisted photogenerated hole and electron transportation to the different area of the surface of photocatalyst. Further, we demonstrated that the plasmon-induced water oxidation reaction takes place at the reaction sites localized at the interface between Au and TiO_2, and the distribution of holes is probed by surface photovoltage imaging. These results give deep insights into the nature of photogenerated charge separation in a single semiconductor photocatalyst particle and provide an exciting opportunity to optimize the performance of solar chemical-conversion devices by utilizing the anisotropic charge-transfer properties of single-crystal semiconductors.

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