Polyphenol-Derived Stable Nanocarbon Layers to Improve Charge Separation, Hole Storage, and Catalytic Activity in Water Oxidation

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Solar water oxidation has regarded as a practically important reaction to enhance the production of green hydrogen in solar water splitting, and modification of photocatalysts with various nanocarbons have been studied to improve intrinsic limitation of semiconductor photocatalysts. However, carbon materials have been rarely utilized in the modification of photoelectrodes due to the difficulty of formation of uniform nanocarbon layers on semiconductor photoelectrode with high efficiency and stability in water oxidation. In this study, we report polyphenol-derived N-doped graphene quantum dots (N-TAGQDs) from tannic acid and form ultrathin nanocarbon layers on a $BiVO_4$ photoanode with Co^{2+} ions ($BiVO_4$/Co/N-TAGQD) by a simple dipping method. A series of (photo)electrochemical analyses suggest the improved performance of $BiVO_4$/Co/N-TAGQD resulted from the synergistic effect between N-doped graphitized tannic acid and the presence of phenolic groups to impart multifunctional roles of improving charge transfer and separation efficiency. We believe that this simple method provides novel approach for design of versatile nanocarbon materials to water-oxidation photoanodes.