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TITANIUM / TITANIUM DIOXIDE SCHOTTKY JUNCTION AND HIGHLY PHOTOACTIVE ANTIMONY SULPHIDE PHOTOANODE FOR SOLAR WATER SPLITING

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Artificial photosynthesis has emerged as a promising solution for producing sustainable chemical fuels, including hydrogen, to address the energy and environmental challenges associated with non-renewable energy sources like fossil fuels. Among the various approaches, photoelectrochemical water splitting, particularly based on metal oxide semiconducting materials, has garnered significant attention. These materials offer suitable band gaps, flat band potentials, low electrical resistance, and excellent corrosion resistance in aqueous solutions, making them ideal for achieving efficient solar conversion efficiency. One such material of interest is Ti/TiO_2 nanotube arrays (TNTA) Schottky junction, which is synthesized through electrochemical anodization. This has captured considerable scientific interest due to their simplicity in synthesis, high electron mobility, and controllable dimensional parameters. By employing a facile electrochemical synthesis strategy on a porous Ti metal sheet, the TNTA Schottky junction is synthesized. To enhance its performance further, the concept of an n/n heterostructure is introduced by coating the TNTA photoanode with an n-type stibnite (Sb_2S_3) layer. Sb_2S_3 is selected for its suitable band gap position and high visible light response. In this study, we have demonstrated that the incorporation of a thin layer of Sb_2S_3 significantly enhances the photoelectrochemical response of the TNTA Schottky junction. The highest photoelectrochemical response of 2.81 mA cm^{-2} was achieved for the $TNTA/Sb_2S_3$ photoanode under AM 1.5 G illumination at 0.8 V vs. RHE in a 0.5 mol dm^{-3} Na_2SO_3 aqueous solution. Notably, this response is more than ten times greater than that observed for the bare TNTA photoanode. The improved performance has been attributed to several factors, including a lower recombination rate of photogenerated charge carriers, broadened spectral response, and enhanced charge transfer/transport occurring at the solid/liquid interfaces, facilitated by the morphology of TiO_2 and incorporation of Sb_2S_3.

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Keywords: Photoelectrochemical Water Splitting, Stibnite, TNTA.