Plasmon-enhanced water splitting of ultrathin BiVO4 photoanode in antenna/spacer/reflector based Au/BiVO4/Au nanostructures

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Monoclinic BiVO4 has been regarded as promising photoanode for photoelectrochemical (PEC) water splitting. However, BiVO4 is limited by a trade-off between the long penetration depth of photons and relatively short length carrier diffusion. Herein, a nanopatterned antenna/spacer/reflector based Au/BiVO4/WO3/Au photoanode is designed by integrating ultrathin BiVO4 film between two kinds of Au nanospheres (NSs) with different sizes. The underlying nanopatterned Au NSs with large size sever as back reflector to reflect the incident light by Bragg reflection, while the surface Au NSs with small size act as antennas to absorb the incident and reflected light, which effectively concentrates the light energy into the BiVO4 layer. Additionally, a strong electromagnetic field is created in the BiVO4 spacer layer due to the strong coupling interaction between the Au reflector and antenna, which promotes the charge separation of BiVO4. Based on the antenna/spacer/reflector structure, the ultrathin BiVO4 of only 70 nm has achieved a photocurrent density of 1.31 mA/cm2 at 1.23 VRHE, demonstrating an impressive 3.23 fold enhancement by the combined plasmonic effects.