Surface modification of Mo-$BiVO_4$ photonic crystal photocatalysts by Au and Ag plasmonic nanoparticles

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Bismuth vanadate ($BiVO_4$) has emerged as the most promising metal oxide photocatalyst for solar water splitting despite persistent electron-hole recombination and poor charge transport [1], which can be ideally combined with photonic crystals (PCs) structuring, metal doping and plasmonic nanoparticles to enhance light trapping, charge carrier generation and separation [2]. In this work, Mo-doped $BiVO_4$ inverse opals were surface modified by plasmonic Au and Ag nanoparticles in order to enhance visible light photocatalytic activity. Well-ordered Mo-doped $BiVO_4$ PC films were fabricated by the self-assembly of polystyrene spheres of different diameters and infiltration of appropriate metal salt precursor with the controlled addition of $(NH_4)_6Mo_7O_{24}{\cdot}4H_2O$ providing Mo^{6+} shallow donors substituting for V^{5+} cations, followed by calcination at 400 ºC. Optimization of metal doping and light trapping was carried out using templating spheres of different diameters and Mo loadings evaluated on salicylic acid degradation after systematic investigation of their properties. TEM measurements along with elemental EDX mapping and XPS analysis identified the uniform distribution of metallic Ag (10 nm) and Au (5 nm) nanoparticles drop coated on the skeletal walls of the optimal Mo-$BiVO_4$-PC340 films. Diffuse reflectance spectra of the surface-modified PC films showed significant reduction of the reflectance peak due to the localized surface plasmon resonance, identified in the absorption spectra of the Ag and Au suspensions at 407 and 521 nm, respectively. Photocatalytic activity evaluation and photocurrent generation under visible light showed a marked enhancement for the Mo-$BiVO_4$ decorated by Au and Ag nanoparticles, respectively.

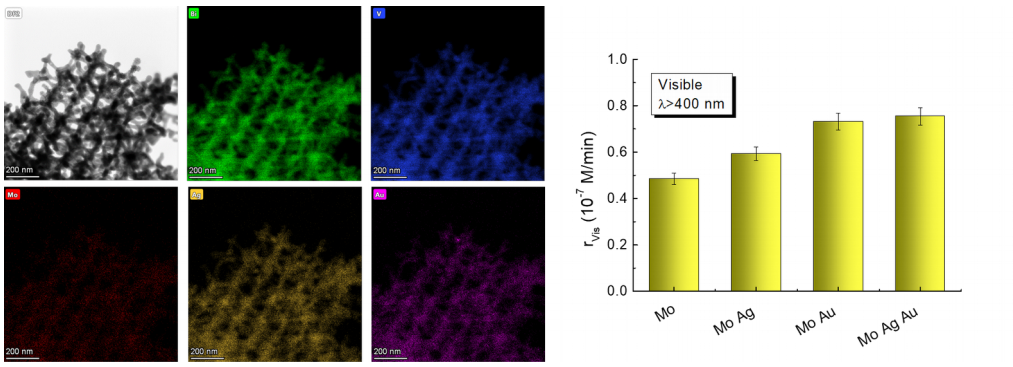

Figure 1: (left) TEM and EDX elemental maps of Ag-Au Mo-$BiVO_4$ PC340 inverse opal films and (right) salicylic acid degradation rates under visible light.

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