Heterostructured Au/Ag-MoS$_2$-TiO$_2$ inverse opal photocatalysts

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Heterostructured Au/Ag-MoS$_2$-TiO$_2$ inverse opal photonic films were fabricated using the evaporation induced co-assembly of polystyrene colloidal spheres with a hydrolysed Ti alkoxide precursor, MoS$_2$ nanosheet and Au/Ag nanoparticle suspensions, in order to enhance the photocatalytic activity of TiO$_2$ in the visible range, where titania is inactive because of its wide band gap [1]. Liquid cascade centrifugation was used in order to select MoS$_2$ nanosheets of smaller sizes [2], which were then loaded on the mixed precursor at variable amounts. SEM measurements showed that low concentrations of MoS$_2$ during synthesis preserve the integrity of the inverse opal structure (Figure 1). The incorporation of MoS$_2$ and Au/Ag nanoparticles in the nanocrystalline TiO$_2$ skeletal walls was investigated by TEM, EDX, and Raman measurements. Photoluminescence and electrochemical measurements were employed to evaluate charge transfer for MoS$_2$-TiO$_2$ in combination with plasmonic effects. Specular reflectance measurements showed that controlling the inverse opal diameter can fine-tune the photonic band gap position, allowing to combine photonic amplification with the optimal film composition that maximizes photocatalytic performance for salicylic acid degradation.

![Figure 1](image)

Figure 1: (a) SEM and (b) TEM images for PC425-MoS$_2$ inverse opals and (c) the corresponding FFT pattern. (d) Raman and (e) specular reflectance spectra of MoS$_2$-TiO$_2$ films. (f) Reaction rates of salicylic acid degradation under visible light.

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References

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