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Silver decorated titanium dioxide for enhanced photocatalytic performance

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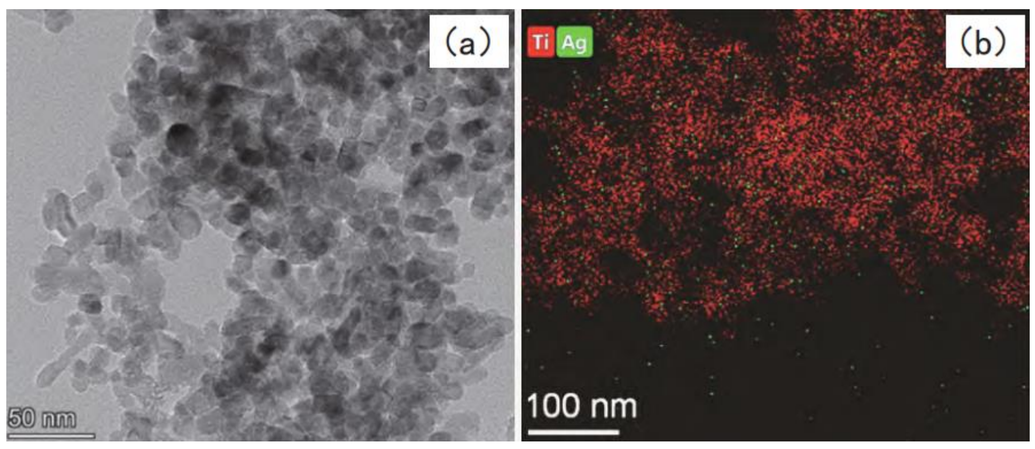
INTRODUCTION & AIM

Titanium dioxide (TiO_2) has been widely recognized as a promising material for addressing fossil fuel dependence and environmental degradation due to its robust photocatalytic activity, stability, and low toxicity. However, pristine TiO_2 suffers from its rapid recombination of photogenerated charge carriers and restricted visible-light absorption. Given this, suppressing charge recombination while extending its photoresponse to visible light would establish pristine TiO_2 as a viable candidate for scalable photocatalysis. Efforts have emphasized depositing noble-metal cocatalysts or creating heterojunctions via advanced synthesis; however, most strategies involve complex procedures, high costs, or poor reproducibility that hinder real-world implementation.

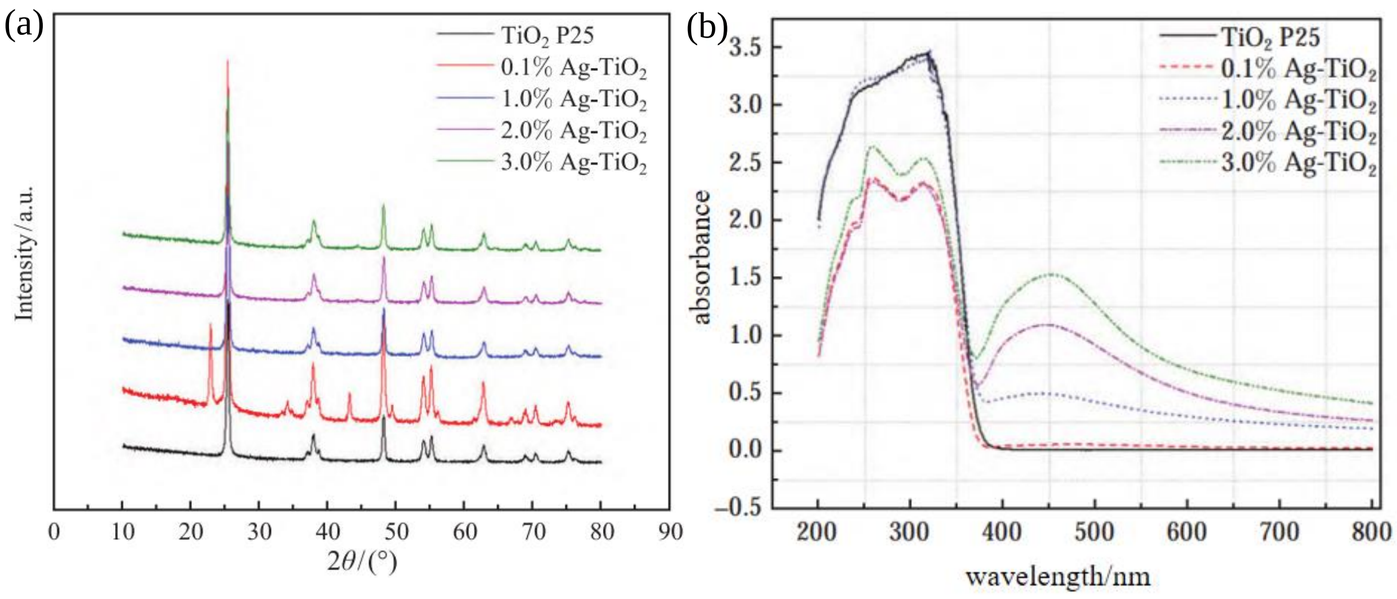
We have developed a controllable synthesis strategy[1] to directly integrate silver (Ag) nanoparticles with semiconducting counterparts. By employing such synthetic routes, Ag nanoparticles ranging from 5-20 nm in size were uniformly anchored onto both the {101} and {001} facets of TiO_2. This composites exhibited improved performance of photocatalytic hydrogen generation and organic pollutant degradation. The enhanced photocatalytic ability is attributed to the formation of stable Ti–O–Ag interfacial bonds. These bonds create an efficient electron-shuttling pathway, accelerating the transfer of photogenerated electrons from the TiO_2 conduction band to the catalytic Ag sites, thereby facilitating charge carrier separation and enhancing light harvesting.

RESULTS & DISCUSSION



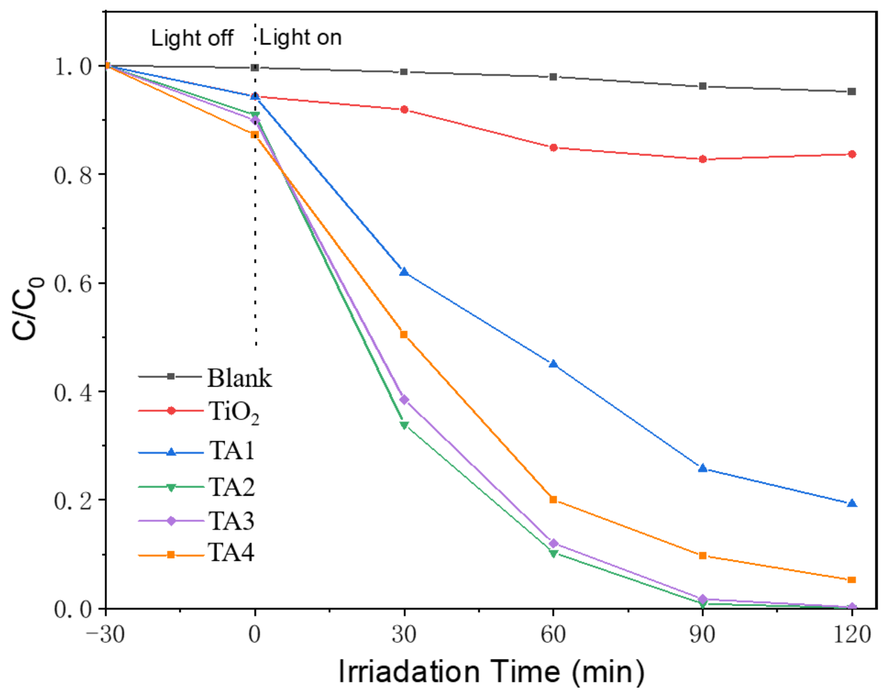
(a) TEM image of TiO_2 /Ag solution and (b) EDS mapping of TiO_2 /Ag.

The crystal morphology of nano TiO_2/Ag particles is relatively regular and the particle size distribution is relatively uniform, mainly concentrated in 10-30 nm.Figure b shows that the distribution of Ti and Ag elements is relatively uniform.



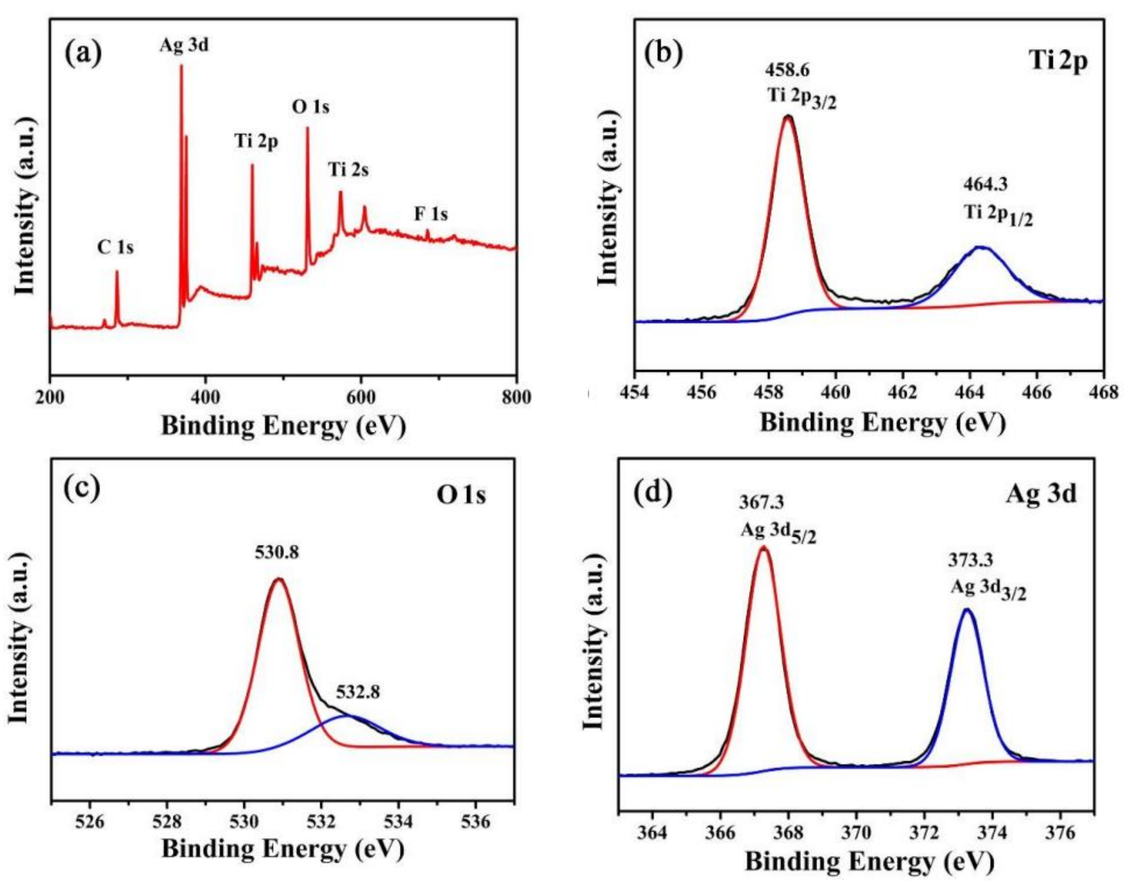
(a)XRD detection results of different catalysts (b) UV visible diffuse reflection spectra of different catalysts

When the wavelength is greater than 400 nm, more Ag nanoparticles are formed due to the SPR effect of Ag loading. In addition, the maximum absorption wavelength of SPR absorption of silver nanoparticles is around 450 nm.



Degradation of MB by binary nanocomposite TiO_2-Ag.

Under light conditions, the MB decreased rapidly over time. Among them, samples TA3 and TA4 exhibited the best degradation performance, reaching 99.89% and 99.76%, respectively, after 120 minutes of illumination.



XPS analysis. (a) Survey scan, (b) Ti 2p, (c) O 1s, (d) Ag 3d

Reference

[1] Xinying Shi, Meng Zhang, Xiao Wang, et al. *Nanoscale*, 2022, 14, 8601–8610.