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Atomic Layer Deposition Of Metal Oxide Inverse Opals: A Promising Strategy For Photocatalytic Applications

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Abstract : Metal oxide inverse opals are a promising class of photocatalysts with a unique hierarchical structure. Atomic layer deposition (ALD) is a versatile technique for the synthesis of high-precision metal oxide thin films, including inverse opals. In this study, we report the synthesis of TiO_2, ZnO, and Al_2O_3 inverse opal and their composites photocatalysts using thermal or plasma-enhanced ALD. The synthesized photocatalysts were characterized using a variety of techniques, including scanning electron microscopy (SEM)-energy dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), Raman spectroscopy, photoluminescence (PL), ellipsometry, and UV-visible spectroscopy. The results showed that the ALD-synthesized metal oxide inverse opals had a highly ordered structure and a tunable pore size. The PL spectroscopy results showed low recombination rates of photogenerated electron-hole pairs, while the ellipsometry and UV-visible spectroscopy results showed tunable optical properties and band gap energies. The photocatalytic activity of the samples was evaluated by the degradation of methylene blue under visible light irradiation. The results showed that the ALD-synthesized metal oxide inverse opals exhibited high photocatalytic activity, even under visible light irradiation. The composites photocatalysts showed even higher activity than the individual metal oxide inverse opals. The enhanced photocatalytic activity of the composites can be attributed to the synergistic effect between the different metal oxides. For example, Al_2O_3 can act as a charge carrier scavenger, which can reduce the recombination of photogenerated electron-hole pairs. The ALD-synthesized metal oxide inverse opals and their composites are promising photocatalysts for a variety of applications, such as wastewater treatment, air purification, and energy production. The ALD-synthesized metal oxide inverse opals and their composites are promising photocatalysts for a variety of applications, such as wastewater treatment, air purification, and energy production.

Keywords : ALD, metal oxide inverse opals, photocatalysis, composites
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