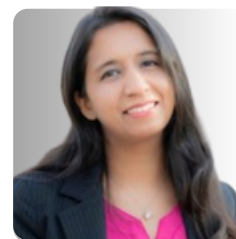


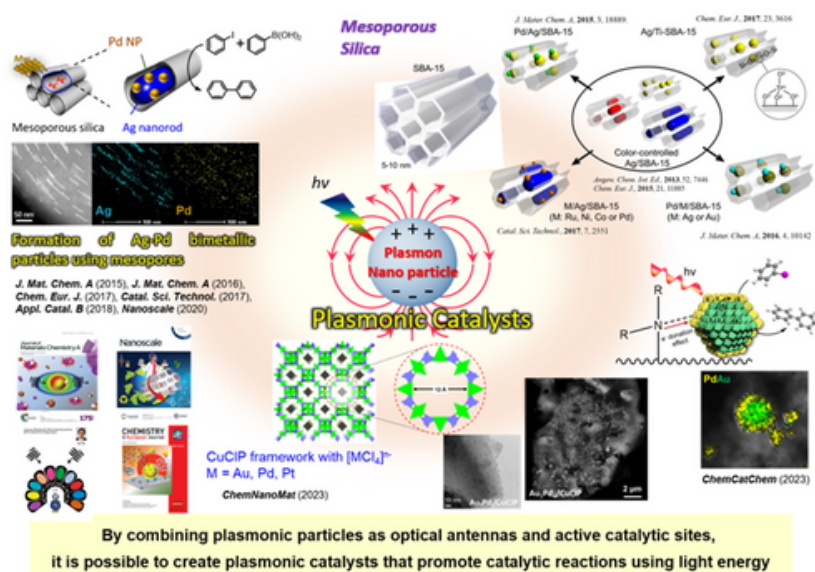
# Design and discovery of novel nanomaterials for plasmonic photocatalysis



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Plasmonic catalysis has remarkably improved product yield and selectivity in various chemical transformation reactions via the localized surface plasmon resonance (LSPR) effect. This phenomenon exploits the collective oscillation of conductive electrons in noble metal nanoparticles (NPs) by the light irradiation of a suitable wavelength. Using porous supports to immobilize plasmonic NPs can prevent sintering and agglomeration and further assist in the easy diffusion of substrate molecules. Scheme 1 illustrates the different plasmonic photocatalytic systems developed to promote catalytic reactions using light energy. The design and application of size and color-controlled Ag NPs within the mesoporous channels of SBA-15 silica for their enhanced catalytic performance in the hydrogen generation from storage material, ammonia borane, under visible light irradiation was demonstrated. The nanocatalysts were prepared by microwave (MW)-assisted alcohol reduction method in which 1-hexanol was used as a solvent and reducing agent in the presence or absence of surface directing agent followed by microwave heating for 3-5 min to form yellow, red, and blue NPs. The combination of the plasmonic metal with catalytically active metal NPs, for example, Pd, Pt, Ru, Ni, and Co, was studied in order to improve the catalytic and plasmonic properties of monometallic nanostructures. A pioneering approach of combining Ag NPs with single-site Ti-oxide moiety was also developed to link together Vis-active plasmonic and UV-active single-site photocatalysts for enhanced hydrogen production activity under UV-vis light irradiation.

In another study, the influence of unique zeotype support material, hierarchically - porous aluminophosphates (HP- AlPO-5), was explored to overcome the mass-transfer limitations with highly accessible active sites. The HP support material was employed to tune the size of plasmonic Au NPs and the efficacy of Pd NPs deposition on the Au surface. The amine functionalization of the support framework was found to play a crucial role in enhancing the stability of bimetallic PdAu NPs. The experiments with the addition of different kinds of amines, for example, primary (-RNH<sub>2</sub>), secondary (-NHR<sub>2</sub>), and tertiary (-NR<sub>3</sub>) groups, along with the presence of one, two, and three nitrogen atoms containing amines, were performed. Based on the characterization results and catalytic response, it was found that the presence of amines assisted in the nucleation and covalent anchoring of the Pd NPs and among all, tertiary amine (-NR<sub>3</sub>) catalyst (PdAu/HP-AlPO-5-NR<sub>3</sub>) was most efficient in achieving significant enhancement in the catalytic performance under visible light irradiation. The HAADF-STEM image with elemental mapping results of PdAu/HP-AlPO-5-NR<sub>3</sub> revealed the close contact of Pd and Au and the presence of nitrogen in the catalyst. A plausible mechanistic pathway of activity enhancement has also been proposed to correlate the promotional effect of amine groups in the plasmon-mediated catalytic performances under visible light irradiation. It has been envisaged that these significant developments will foster future technological advancements in solar-powered catalysis for practical applications.



*An illustration of different plasmonic photocatalytic systems to promote catalytic reaction using light energy*

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