Densely Packed UV-Visible Light Responsive Photocatalytic Pairs in Hexagonally Arrayed Silicate Nanochannels for Hydrogen Production

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Abstract

The use of UV-visible light responsive catalysts in hydrogen production is of constant high interest owing to deteriorating energy and environment resources. Here, we present a highly efficient system for photocatalytic hydrogen production, comprising a novel visible-light-responsive polyoxotungstate (Phosphotungstic acid, PTA) catalyst embedded along the walls of ordered silicate nanochannels of arrayed co-catalytic platinum nanoparticles within. The UV-visible-light-responsive PTA catalyst is synthesized by replacing a corner WO^{4+} of PTA with Ni for Ni-ℓPTA, and then embedded to the walls of ordered silicate channels during synthesis of the MCM41-based template at an air-liquid interface. With in situ grazing incidence small-angle X-ray scattering (GISAXS) on the air-liquid interface, formations of the ordered and oriented silicatropic template and the subsequent formation of Pt NP arrays in the template are traced. The silicate channel template with Ni-ℓPTA (Ni-ℓPMS) assists subsequent formation of arrays of densely packed Pt nanoparticles within the silicate channels upon UV-visible light irradiation, via anion exchange of the Pt-metal precursors and the surfactant micelles. The hence formed composite with the efficient catalytic pairs of Pt-NP and polyoxotungstate demonstrates efficient generation and transport of photo-electrons for hydrogen production upon light illumination. The hence formed nanocomposite of closely packed catalytic pairs of Ni-ℓPTA and Pt nanoparticles along the 2D hexagonally ordered silicate nanochannels, demonstrates highly elevated hydrogen production upon illumination, compared to systems with PTA alone or with randomly dispersed Pt nanoparticles.

***Keywords:** UV-Visible-Light-Responsive PTA, Arrayed Pt nanoparticles, Photocatalytic hydrogen production, meso-ordered silicatropic template, grazing incidence small-angle X-ray scattering*