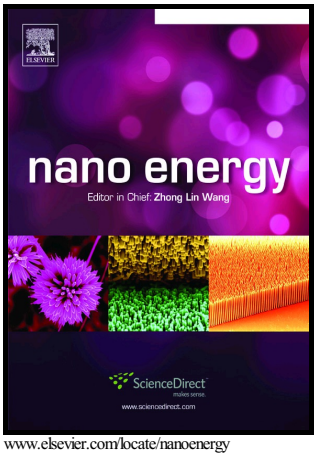

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Controllable Spatial Effect Acting on Photo-induced $CdS@CoP@SiO_2$ Ball-in-Ball Nano-photoreactor for Enhancing Hydrogen Evolution

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Abstract

Size-controllable interior cavity of the ball-in-ball $CdS@CoP@SiO_2$ nano-photoreactor was fabricated using one-step hydrothermal method, Stöber method and combined with partially etching technique, and the size of inner-cavity can be precisely controlled with the different etching time. The experimental results show that the sample with a cavity diameter of 530 nm exhibits greatly higher photocatalytic activity and excellent stability compared with other sizes of inner-cavity samples and pure CdS@CoP sample, which could be attributed to its formed nanostructure properties, such as the proper inner-cavity distribution, visible light multi-scattering effect as well as reagent enrichment effect that confirmed by the NO removal reaction. However, noted that the ball in ball structure with interior cavity does not certainly improve the solar-driven hydrogen evolution under the visible light irradiation ($\lambda \geq 420$ nm), as is evident from the photocataytic activity of $CdS@CoP@SiO_2$ (CSC-1) with a cavity diameter of 450 nm shows the lower hydrogen evolution than pure CdS@CoP sample. These results exhibit that the size of the confined space plays a significant role in enhancing photocatalytic activity of the as-prepared nano-photoreactor. In addition, in order to further proof the function of the spatial cavity and the universality of this ball in ball nanostructure, we also prepared a series of referenced $CdS@SiO_2$ nano-photoreactor to validate again the spatial effect and apply in photocatalytic H_2 evolution (HER). As a result, the referenced photo-reactors also reveal the similar photocatalytic trend of HER activity, which aids the suitable size of spatial cavity indeed plays a crucial part in boosting photocatalytic H_2 generation and provides an innovative direction to further enhance HER activity. More importantly, exploring the factors over the different sizes of interior cavity can create a potential platform for designing the reasonable scale of the