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In-situ Study of CdS/metal oxides Heterostructures: Photocatalytic Activity Behavior

Although CdS is a promising photocatalyst based on visible light, it is highly toxic. Therefore, in addition to research to improve its photocatalytic properties, attention should also be paid to its ability to be recovered, taking into account environmental aspects. One of the easiest ways to recover photocatalytic nanoparticles is to add magnetic nanoparticles to CdS to create a heterostructure. In this study, Fe_3O_4 (ferrimagnetic) and CoO (paramagnetic) NPs with different magnetic properties were combined with CdS to synthesize CdS/Fe_3O_4 and CdS/CoO heterostructure systems, and both the photocatalytic degradation efficiency and the recovery efficiency of the NPs were measured. The two heterostructures showed significant improvement in photocatalytic properties compared with CdS, but showed distinct differences in recovery efficiency due to their magnetic properties. The CdS/Fe_3O_4 heterostructure system was found to be the most suitable system for the purpose of this study, as its photocatalytic properties were enhanced compared to CdS and its magnetic properties did not show a significant degradation compared to Fe_3O_4. For CdS/Fe_3O_4 heterostructure system, the conversion of 2,5-hydroxymethylfurfural to 5-formylfuran-2-carboxylic acid was increased by ~22% compared to CdS. Furthermore, the magnetic properties were only degraded by ~6.8% compared to Fe_3O_4 NPs, confirming their applicability. Visible light photocatalytic conversion experiments were performed to measure the photocatalytic properties of the two heterostructures, and in situ X-ray photoelectron spectroscopy was used to determine the changes in electronic structure under optimized conditions.

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