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種別(和文)	論文要旨
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（博士課程）
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	Wu, Jhen-Yang	審査員主査： Chief Examiner	Chang, Tso-Fu Mark

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This thesis is titled "Materials Design and Fabrication of Metal-Embedded Core-Shell and Yolk-Shell Nanocrystals and Characterization of the Charge Transfer Mechanism and Photocatalytic Activity," and is composed of five chapters.

Chapter 1, "General Introduction," explains the fundamentals of core-shell and yolk-shell nanocrystals as photocatalysts. This chapter focuses on the synthesis methods of nanocrystals and various photocatalytic activities (such as dye degradation, hydrogen generation, and carbon dioxide reduction), exploring the mechanism of charge transfer. It clarifies the aim of the thesis, outlining the impact of different metals combined with Cu_2O on photocatalytic performance, and the sustainability of nanomaterials in wastewater treatment. In addition to the technical background, it details the research motivation and objectives, providing a deep understanding of the application of nanotechnology in the field of photocatalysis and its environmental impact. This enables readers to gain fundamental knowledge on the significance of nanocrystals as photocatalysts and how they can contribute to environmental conservation. Furthermore, this chapter serves as an introduction to the research content of the subsequent chapters, clearly defining the overall research framework and its significance.

Chapter 2, "Material Design and Fabrication of Metal@Cu_2O Core–Shell," presents detailed experimental methods for the synthesis of core-shell nanocrystals, especially focusing on the preparation of Au, Ag, and Pd colloids and the fabrication process of metal@Cu_2O core-shell nanocrystals. Advanced analytical techniques are employed to understand the physical and chemical properties of these nanocrystals. In particular, detailed characterizations using electron microscopy, X-ray diffraction, and X-ray photoelectron spectroscopy are conducted. A crucial part of this chapter is the experimentation on the

photocatalytic activity of the synthesized nanocrystals, particularly their effect on the photocatalytic degradation of methylene orange (MO). These experiments provide key indicators for evaluating the efficiency and functionality of these nanocrystals as photocatalytic materials. Moreover, detailed discussions on the morphology, crystal structure, chemical state, electron interactions, light absorption, and charge transfer mechanism of the nanocrystals are provided, offering deep insights into how these physicochemical properties affect photocatalytic activity.

Chapter 3, "Effects of Shell Thickness in Au@Cu_2O Core-Shell Nanocrystals for Photodegradation," delves deeper into experimental studies on the application of core-shell nanocrystals, exploring how these nanostructures contribute to specific photocatalytic reactions. At the beginning of the chapter, experimental procedures for synthesizing Au@Cu_2O core-shell nanocrystals with different shell thicknesses and their subsequent applications are introduced, especially detailing the method for immobilizing these nanocrystals on polyethylene terephthalate (PET). This technique is crucial for enhancing the efficiency of photocatalytic reactions and opens new paths for expanding the application range of nanocrystals. Photocatalytic degradation experiments of dyes such as MO and methylene blue (MB) are conducted, evaluating how these nanocrystals enhance photocatalytic reactions. Additionally, the effect of nanocrystals in photocatalytic treatment of simulated textile wastewater is examined, demonstrating their potential in environmental purification. Scavenger experiments and photoelectrochemical measurements are conducted to understand the mechanism of the photocatalytic degradation process, and these results are valuable for a deep understanding of the photocatalytic properties of nanocrystals.

Chapter 4, "Material Design and Fabrication of Series of Yolk-Shell Nanostructures," focuses on further applications and characterizations of yolk-shell nanocrystals. In particular, in addition to the synthesis of Au@Cu_2O core-shell, various yolk-shell nanocrystals such as Au@Cu_7S_4, Au@CdS, Au@ZnS, and Au@Ni_3S_4 are examined for their fabrication methods and properties. These nanocrystals, each with unique morphology, crystal structure, and chemical state, are expected to play different roles in photocatalytic reactions. An important aspect of this chapter is the detailed analysis of the morphology and crystal structure of these nanocrystals. Techniques such as electron microscopy and X-ray diffraction are

used to evaluate the shape, size, and crystallinity of the nanocrystals. These properties directly affect the light absorption characteristics and charge transfer mechanism of the nanocrystals, thereby significantly influencing their photocatalytic activity. Furthermore, deep insights into the chemical state and electron interactions are provided. Analyses using X-ray photoelectron spectroscopy reveal the chemical bonds and electronic states between different elements within the nanocrystals, enhancing our understanding of how these affect the mechanism of photocatalytic reactions. Studies on light absorption and charge transfer mechanism are particularly noteworthy. These investigations detail how the nanocrystals absorb light and how the generated electrons and holes are efficiently separated, key elements for achieving high photocatalytic efficiency and important considerations in the design and synthesis of nanocrystals.

Chapter 5, "General Conclusion," succinctly summarizes the pivotal results obtained throughout the thesis, spotlighting the high efficiency and specificity exhibited by core-shell and yolk-shell nanostructures in photocatalytic processes. The chapter elaborates on the exceptional capabilities of these nanostructures in enhancing various photocatalytic reactions, with a special emphasis on their role in environmental remediation and energy production applications. It highlights the nanostructures' significant achievements in the degradation of harmful dyes, showcasing their potential in purifying water sources contaminated with industrial pollutants. Additionally, the chapter points to the nanostructures' effectiveness in hydrogen generation through water splitting, illustrating their contribution to the development of sustainable energy resources. The reduction of carbon dioxide into useful compounds is also discussed, underlining the nanostructures' part in combating climate change by converting greenhouse gases into renewable fuels. The chapter concludes by reaffirming the novel insights provided by the thesis on the advanced photocatalytic performance of core-shell and yolk-shell nanostructures, setting a foundation for future research in this promising field.