

# Preface

Nanoscience is an intersection of chemistry, physics, materials science, biology, electrical engineering, and many other disciplines to study matters at nanometer scale. More specifically, this multidisciplinary field is focused on matters with at least one dimension sized from 1 to 100 nm. In parallel to quantum dots that were invented earlier, metallic nanostructures have attracted tremendous attention from the research community, and their research has become a fast-growing subfield of the nanoscience. Metals possess a range of wonderful properties, leading to extensive use in industrial applications including catalysis, electronics, photography, and magnetic information storage. As the dimensions of metallic materials shrink down to the nanoscale, they give birth to numerous new applications such as photonics, imaging, and medicine. Undoubtedly, a majority of these promising applications require the use of metals in a finely divided state, which not only brings about grand challenges to materials synthesis, but creates opportunities for chemists to collaborate with the scientists of various academic backgrounds.

The history of solution-phase synthesis—the most widely used approach to metallic nanoparticles can be traced back to the 1850s when Michael Faraday invented his now famous gold colloids. However, not until the recent decade had the controllability over size, shape, structure, and composition of metallic nanostructures reached the level usable for realistic applications. Now, the solution-phase methods can offer the quality, quantity, and reproducibility suitable for shape-property relationship investigations, which significantly blossoms the research and implementations of metallic nanostructures. Nevertheless, the people having insufficient chemistry training still suffer from the difficulty of transferring literature knowledge to bench work in wet labs. “Enabling anyone to make desired metal nanomaterials in a wet lab” is thus one of the major motivations of writing this book. Needless to say, understanding the designing rules for nanomaterials is also an obstacle to the chemists working on materials synthesis. Leveraging example applications, this book illustrates how to design a perfect metallic nanostructure for the application which the readers are specifically interested in. We do hope, by bridging controlled synthesis and applications, it will make it more clear how fascinating and versatile metal nanomaterials are.

This is the first book to address the fundamentals in the controlled synthesis of metallic nanostructures toward fulfilling specific functions, and is intended for the scientists and engineers making efforts in the fields related to nanotechnology. Here we just name a few examples: materials science, chemistry, physics, electronics, magnetic information storage, catalysis, biotechnology, optics, and photonics. Although it is not specially designed for a university textbook, it does not bother this book to become a reference for the college and graduate students studying the courses related to nanotechnology and materials science. Specifically, Chap. 1 first gives an overview on the fundamentals in the field of metallic nanostructures. Chapters 2 and 3 provide basic knowledge relative to metallic nanomaterial synthesis and allow the readers to have a clear picture for making desired metallic nanoproducts via direct synthesis or seeding growth. Chapters 4–9 illustrate the structure-dependent properties of metallic nanostructures for interfacial molecular interactions, biomedicine and sensing, electrocatalysis and catalysis, photonics and electronics, and magnetic applications case by case. They fully demonstrate what applications metallic nanomaterials can be implemented in, leading to the bright future of this research. We do hope that this book coherently integrates synthesis fundamentals with material functions and can unravel the puzzle that people frequently encounter when designing metal nanostructures for various applications.

Overall, the objective of this book is to strengthen research in metallic nanostructures by creating a coherent framework of fundamental understanding and case study for various disciplinary nanoscience communities. It represents a further step in the research of metal nanomaterials to achieve rational design materials. At the same time, it constitutes an updated overview of the state-of-the-art and a roadmap, reflecting frontier research trends in each subfield of metal nanomaterials.

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