Shape- and Size-Controlled Synthesis of Noble Metal Nanoparticles

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Abstract. Noble metal nanoparticles (mainly Au, Ag, Pt and Pd) have received enormous attention owing to their unique and fascinating properties. In the past decades, many researchers have reported methods to control the shape and the size of these noble metal nanoparticles. They have consequently demonstrated outstanding and tunable properties and thus enabled a variety of applications such as surface plasmonics, photonics, diagnostics, sensing, energy storage and catalysis. This paper focuses on the recent advances in the solution-phase synthesis of shape- and size-controlled noble metal nanoparticles. The strategies and protocols for the synthesis of the noble metal nanoparticles are introduced with discussion of growth mechanisms and important parameters, to present the general criteria needed for producing desirable shapes and sizes. This paper reviews their remarkable properties as well as their shape- and size- dependence providing insights on the manipulation of shape and size of metal nanoparticles, necessary for appropriate applications. Finally, several applications using the shape- and size-controlled noble metal nanoparticles are highlighted.

Keywords: metal nanoparticles; size and shape; growth mechanism; properties; applications

1. Introduction

Throughout human history, metals, which cover more than two thirds of the elements, have been an important and necessary material in a variety of fields. Nowadays, the characteristics of metallic materials can be modified due to nanotechnology, and their properties can be dramatically changed by altering their large surface-to-volume ratio, and confinement of electromagnetic components. (Sau 2009) As a result, nano-sized metal particles exhibit unique and outstanding physical, chemical, electrical, optical and catalytic properties compared to their bulk counterparts (Burda 2005, Wilcoxon 2006, and Daniel 2004). Because of these remarkable properties, metal nanoparticles are considered to be promising materials for use in plasmonics, diagnostics, sensing,

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