

Synthesis of Au-Cu Nano-Alloy from Monometallic Colloids by Simultaneous Pulsed Laser Targeting and Stirring

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Abstract: Experimental work has been focused on the formation of alloyed Au-Cu nanoparticles under simultaneous laser exposure and mechanical stirring of mixed monometallic colloids, here referred to as dual procedure. As a feed for the dual procedure, Au and Cu monometallic nanoparticle colloids have been using a laser ablation technique. To accomplish this, bulk targets were ablated with 1064 nm wavelength Nd: YAG laser in a pure acetone (99.99%) environment. Ultraviolet-visible optical absorption spectrometry, transmission electron microscopy, X-ray diffraction and X-ray fluorescence technique have been used to characterize the nanoparticles. It has been found that experimental conditions such as stirring and laser parameters strongly affect the synthesized particle properties, including the size, shape, composition and stability of the nanoparticles. Alloy nanoparticles containing 39% Au – 61% Cu have also been prepared in the same process, but in two forms of a homogeneous alloy and a core-shell structure.

Keywords: Laser ablation; Alloyed Au-Cu nanoparticles; Dual procedure; Laser exposure; Mechanical mixing; Core-shell

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Introduction

In recent years, bimetallic nanoparticles (NPs) have gained much attention due to their applications as catalysts [1-3], in electro-optics [4] and for changes in surface plasma band energy [5, 6]. Their shape, size, composition, crystallinity and structure can be influenced by the experimental conditions during the preparation [7]. To produce NPs, different physical methods and combination techniques have been reported to date. Specific advantages of laser ablation technique (LAT) are its simplicity and versatility [8, 9], well controlled exposure time [9], and the creation of pure NPs from colloidal dispersions with no formation of by-products [10]. On the other hand, colloids produced by chemical methods are usually contaminated with residual by-products such as

ions and reducing agents, which is especially critical in biological applications [11]. In addition, LAT has been used for preparing various NPs such as noble metals [12], alloys [13, 14], oxides [15] and semiconductors [16]. In submerged LAT, a laser beam ablates an immersed solid target at the liquid-solid surface [17]. In doing so, numerous novel possibilities could be reliably realized to create unique experimental conditions. These include laser parameters (wavelength, pulse duration, energy per pulse), ambient gas pressure and target distance. Such parameters can be used to control the shape and size distribution of the NPs [18]. NPs of Ag and Cu have been produced in many liquids [19, 20]. LAT with a single or double pulsed laser has been used to obtain metallic alloy NPs of Au-Ag and Ag-Cu in colloids in several contexts [21].

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