Nanosecond pulsed laser ablation to synthesize ternary alloy colloidal nanoparticles

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3.1 Introduction

Nanoparticles are highly interesting for biological, medical, energetic conversion, and storage and electronic applications [1–4]. Nanoparticles have a large surface and surface-to-volume ratio. The metal nanoparticles have distinguished electrical, magnetic, optical, and chemical properties with marvelous new applications [5–8]. The last decade has seen the development of nanoparticles with controlled sizes, shapes, and phases. Different techniques such as thermal evaporation, milling, the chemical method, condensation, and sputtering [9–13] have also been reported. However, these techniques were either expensive or may produce toxic materials or impure, harmful, and low-quality nanoparticles that tend to agglomerate toward a bigger size. A lot of attention and interest were paid to synthesizing nanoparticles by pulsed laser ablation (PLA) [14–16]. PLA has offered nanoparticles for nanofertilizers, surface-enhanced Raman scattering detection, and biotechnology applications [17–20]. The main feature of PLA is its capability to produce stable colloidal nanoparticles. It is safe, clean, and effective for metal nanoparticle synthesis with controllable size [21–25]. It is demonstrated that mean size and size distribution of colloidal nanoparticles produced by PLA depend significantly on laser fluence, wavelength and pulse duration characteristics, a liquid environment, and target material [26–30].

Aguilar-Castillo et al. [31] have synthesized HfO$_2$ nanoparticles doped with Eu$^{3+}$, Tb$^{3+}$, and Eu$^{3+}$+Tb$^{3+}$ ions by pulsed laser ablation excited through photoluminescence and cathodoluminescence and have investigated their luminescence properties. They have shown that the surface morphology exhibited a low roughness. It also shows a white emission under excitation with 320 nm in case of codoping with Eu$^{3+}$ and Tb$^{3+}$ ions. Lerner et al. [32] have synthesized Al nanoparticles and Al/AlN nanocomposites. They have demonstrated that the electrical explosion of wires and the gas medium influenced the average size of the produced nanoparticles and the content of AlN in the powder. You et al. [33] have deposited Al-doped ZnO by pulsed laser ablation of Zn and Al targets in oxygen plasma. Zn ablation resulted in a reactive