



Fabrication of magnesium metallic nanoparticles by liquid-assisted laser ablation

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Received 25 May 2020; revised 15 July 2020; accepted 21 July 2020; posted 21 July 2020 (Doc. ID 398543); published 14 August 2020

Magnesium metallic nanoparticles have been synthesized using the pulsed laser ablation in liquid media technique (PLAL) in the range of 20–30 nm by varying the laser ablation time. During the laser ablation process, the laser-induced breakdown spectroscopy (LIBS) technique is used to investigate the physicochemical properties as laser-induced Mg plasma in terms of spectral line intensities and their plasma parameters (n_e and T_e). The X-ray diffraction technique and UV-visible technique show that the produced samples have a crystalline structure, and as the laser ablation time increases, the value of the absorption peak shifts to lower wavelengths and the average particle decreases, respectively. The use of the PLAL technique shows the capability to produce a metallic structure based on purging the solution by molecular nitrogen. The use of the LIBS technique shows a good and fast tool for detecting their particle sizes and the differentiation between the metallic form and its oxide structure. © 2020

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<https://doi.org/10.1364/JOSAB.398543>

1. INTRODUCTION

Nanomaterials science is one of the most appealing research interests nowadays. Nanoparticles (NPs) are substances of at least one dimension in the nanoscale range, granting them exceptional physical and chemical properties, such as electrical and thermal conductivity, quantum effects, extreme reactivity, and large surface-to-volume ratios [1]. These exceptional properties allowed NPs to be extensively used in various scientific research fields [2]. They have been used as catalysts for the decomposition of a number of specific environmental contaminants like halogenated fabrics, halogenated organic solvents, and toxic metals [3]. Numerous studies have been conducted on metals and their oxides due to their extraordinary electrical, optical, catalytic, and magnetic properties. They have been widely used in a variety of industrial, agricultural, environmental and medical applications, and their use continues to expand [4,5]. They could be synthesized by stabilizing and reducing chemicals at different trophic levels with different conventional techniques [6]. It is likely that they have detrimental effects on humans and the natural environment in general, e.g., by creating various kinds of pollutants and toxins that may adversely influence microbial ecosystems and hence the entire ecosystem

[7]. In order to avoid adverse effects of chemically based reaction during development of nanomaterials, scientists are now seeking alternatives [8].

Pulsed laser ablation in liquids (PLAL) is one of the promising techniques in the field of green synthetic tools [9,10]. It is based on the use of a liquid-phase synthesis route of nanoparticles with the assistance of the pulsed laser ablation process. The liquid-phase synthesis route is an environmentally friendly process, since it avoids the products of nanostructure materials that could penetrate the human skin or enter the human body via inhalation. Moreover, the advantages of this technique includes the production of diverse materials with high purity and interesting surface chemistry, without minor products [11]. Laser interaction with the target surface immersed in liquid media produces a plasma plume of extremely high temperature surrounded by liquid molecules. Eventually, nanomaterials are produced. However, the most significant drawback of this technique is its low mass product that leads to the complexity of the characterization process [12]. Thus, using the features of the produced plasma plume for the characterizations process could be considered an optimum way to overcome this problem. Laser-induced breakdown spectroscopy (LIBS) is a sensitive technique for inorganic atomic and molecular species. It monitors the produced emission signals from the plasma plume of the metal target which is immersed in liquid media