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ABSTRACT

Alumina nanoparticles with different average particle sizes were synthesized by pulsed laser ablation of Al plates in ethanol, followed by laser irradiation at different times. Their optical and structural properties were investigated by different techniques. The experimental work showed that as the time of post-laser irradiation increased, the average particles' size of alumina decreased. The decrease in the particle size is detected by using x-ray diffraction (XRD) technique and UV-visible absorption spectroscopy technique (UV–VIS) and characterized by laser-induced breakdown spectroscopy (LIBS). The LIBS technique was utilized as a diagnostic tool with XRD and UV–VIS for determining the nanoparticles' size. Laser-induced plasma parameters such as electron density and electron temperature were determined. A relationship has been established between the electron temperature and the nanoparticles' size. The results reflect the significance of correcting the spectral intensity of the emitted line for the effect of self-absorption in the LIBS experiment.

I. INTRODUCTION

Over the last few decades, the field of nanostructured materials has gained a great deal of attention due to their recently discovered characteristics and promising applications in numerous fields such as catalysis, optoelectronics, electronics, energy research, and others.[1–4] The nanostructured materials could be metals, oxides, carbides, or sulfides. Researchers are interested in the synthesis of metal oxides. Therefore, they have been using metal oxides in a wide variety of fields, including catalysts, medical research, sensors, capacitors, and semiconductors. Alumina is one of the widely used oxides due to its fascinating characteristics, including high melting point, low conductivity, and thermal and chemical stability.[5] Furthermore, they have been found to be used as catalysts, catalytic agents, adsorbents, and wear-resistant coatings. Also, they are the most used nanomaterials in producing packing, semiconductor materials, and cosmetic fillers.[5]

In recent years, several techniques have been utilized for the synthesis of alumina, such as hydrothermal,[6] sputtering,[7] laser ablation,[8] mechanical milling,[9] pyrolysis,[10] precipitation,[11] and solgel methods,[12] but it is unfortunate that the nanomaterials of metals or metal oxides are likely to have a harmful effect on humans and the surrounding environment in general, e.g., by producing different classes of contaminants and toxins that can unfavorably affect microbial societies, with a knock-on impact to the entire ecosystem.[13] Therefore, today, scientists and researchers are looking for an alternative technique to eliminate the harmful effects of chemical reactions during the production of nanomaterials based on the synthesis of nanostructure of metals and their oxides using