Enhancement in NELIBS with Silver and Gold Nanoparticles and N-Graphene Quantum Dots

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The interest in Nanoparticle-enhanced Laser-induced Breakdown Spectroscopy (NELIBS) has been a growing in the LIBS community since the first report of De Giacomo et al.[1], because of its capacity to increase the signal in the spectra. In NELIBS, typically metal nanoparticles (NPs) are deposited over the surface of the sample prior to conducting the LIBS analysis. The signal improvement caused by the NPs has permitted, among other things, lowering the limit of detection (LOD) of several elements in different kinds of materials (metallic, transparent dielectric, and biological). Despite of this improvement, NELIBS reproducibility and variability presents issues that need to be further investigated, also whether other kinds of NP that can generate this effect. In this work, over 18,000 spectra were analyzed. These spectra resulted from 600 different combinations of nanoparticle diameters (D), surface concentrations (SC), and laser fluence. The samples consisted of aluminum alloy (98%) plates. Both, gold (Au) and silver (Ag) NPs were synthetized, characterized by optical absorbance, and deposited on the surface of the plates.[2] [3] Additionally, N-doped Graphene quantum dots (~2 nm) were applied to evaluate their performance in NELIBS.[4] The effect of the deposits and the other parameters was systematically investigated. For every combination, 30 shots were taken, at 10 laser fluence levels. Citric acid was used to avoid the Coffee Ring Effect to better distribute the NPs on the surfaces. For enhancement assessment, four aluminum peaks were explored (308.3, 309.4, 394.3, 396nm). Maximum enhancements were determined for given combinations, in all cases.

[1] A. De Giacomo et al., Anal. Chem., vol. 85, no. 21, pp. 10180–10187, 2013.

[2] S. Agnihotri et al., RSC Adv., vol. 4, no. 8, pp. 3974–3983, 2014.

[3] N. G. Bastús et al., Langmuir, vol. 27, no. 17, pp. 11098–11105, 2011.

[4] X. Sun et al., Molecules, vol. 24, no. 2, 2019.