Nanoparticles via Pulsed Laser Ablation in Liquid (PLAL) and their application to Laser Induced Breakdown Spectroscopy (LIBS) for signal amplification: a ruby case study

F. Leone[1], A. De Giacomo[1,2], M. Dell'Aglio[2]

[1]Department of Chemistry, University of Bari, Italy
[12]CNR-IFN (National Research Council - Institute for photonics and nanotechnologies), Bari, Italy

*Corresponding author email: leonefilippo2001@gmail.com

In this work, metallic nanoparticles (NPs) were produced by using Pulsed Laser Ablation in Liquid (PLAL). These NPs were subsequently used to enhance the signal in the Laser Induced Breakdown Spectroscopy (LIBS) technique. The use of NPs in LIBS (Nanoparticle Enhanced LIBS) allows a reduction of the limit of detection (LOD) of the elements belonging to the analyzed sample by improving the atomization efficiency thereby creating a plasma richer in excited atoms and ions. An interesting application of NELIBS is the elemental analysis of gemstones [1] since it can allow simultaneous analysis of light elements such as Li, Be, and B, as well as heavy elements such as Fe, Cr, and Pb which can be indicative of the origin of the gem, and in particular, if it is synthetic or natural. Moreover, the use of NPs avoids surface damage visible to the naked eye (Figure 1) because NELIBS allows the employment of low laser energy. In this study, NELIBS was used to determine the major trace elements present within a ruby. Firstly, the concentration of Cr, was measured by employing a calibration curve built with Cr-glass matrix matched standards. Then, after the determination of plasma temperature and electron density, a calibration free (CF) method based on the Local Thermodynamic Equilibrium (LTE) was applied to determine the concentrations of the other trace elements. The knowledge of trace element chemistry can be finally used for the diagnostic of a synthetic product. In this work, based on the study in [2], the correlations among TiO_2, FeO, and V_2O_3 were employed to investigate the nature of the analyzed ruby.

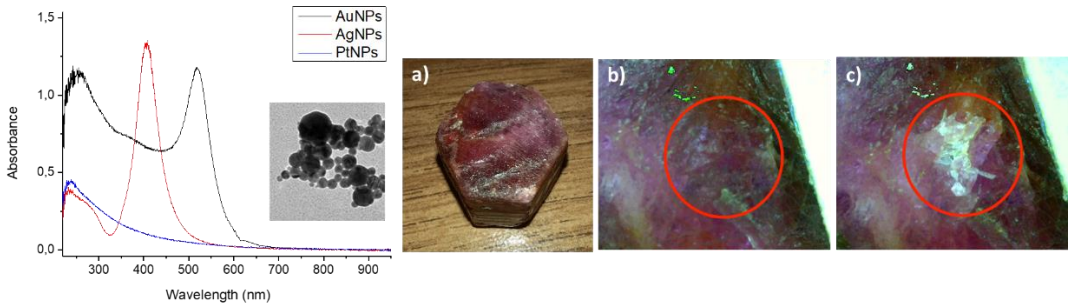

Figure 1 Produced NPs by PLAL and a) ruby case study analyzed with b) NELIBS and c) LIBS.

References:

[1] Koral, C., Dell'Aglio, M., Gaudiuso, R., Alrifai, R., Torelli, M., De Giacomo, A., Nanoparticle-Enhanced Laser Induced Breakdown Spectroscopy for the non invasive analysis of transparent samples and gemstones (2018) Talanta, 182, pp. 253-258.

[2] S. Muhlmeister, E. Fritsch, J. E. Shigley, B. Devouard, B. M. Laurs, Separating Natural And Synthetic Rubies On The Basis Of Trace-Element Chemistry, Gems & Gemology, Summer 1998