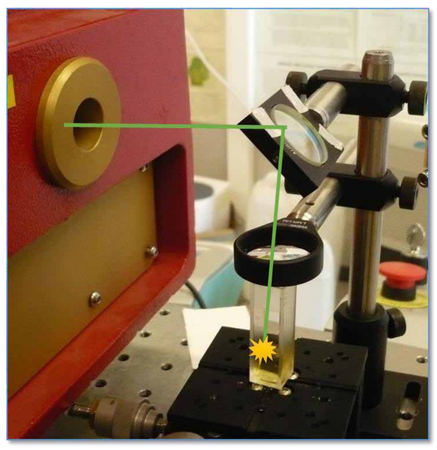
Nanoparticle Size and Concentration Estimation by Calibration Line Method by Laser-Induced Breakdown Spectroscopy

Can Koral[a,*], Marcella Dell'Aglio [b], Remah ElRashedy [a], Rosalba Gaudiuso [a,b], Alessandro De Giacomo[a,b]
[a]Department of Chemistry, University of Bari "Aldo Moro", Bari, 70126, Italy
[b]*CNR-IMIP sec. Bari, Bari, 70126, Italy*

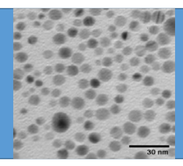
Can Koral, can.koral@ba.imip.cnr.it

- **Having a fast technique for size and concentration characterization of NPs solutions is of extreme importance for the orientation of NPs to industrial and daily life products.**

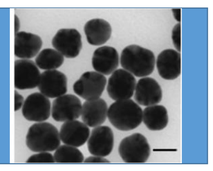
- **Ag NPs of different size produced by laser ablation in liquid [1].**



10nm AgNPs
0.02 mg/ml in aqueous buffer,
NanoComposix, Inc.

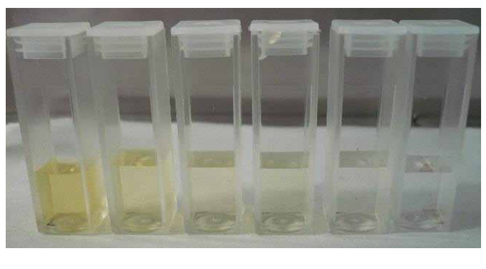


20nm AgNPs
0.02 mg/ml in aqueous buffer,
Sigma Aldrich Co.



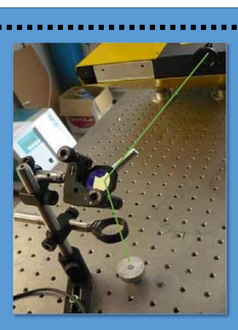
8nm AgNPs by Ablation

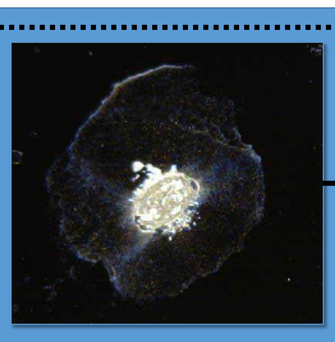
A series of solutions with different concentrations were prepared by direct dilution by deionised water



Particle size distributions were characterized by UV-VIS spectrometer and absorption results were crosschecked with certified AgNPs dispersions

0.5µl drops of NPs colloids were put on silicon wafer substrate.





The solution was then evaporated by a focused single laser shot to form a homogeneous coating layer of NPs on a circular area of 3.5 mm in radius.

- **In this work a specifically designed Laser-Induced Breakdown Spectroscopy (LIBS) setup was constructed to characterize the NPs size and the concentration of the colloids.**
- **The acquisition conditions were: Time Delay 800 ns, Gate Width 10 µs, Laser Fluence 5 J/cm², Spot Size 3.5mm.**

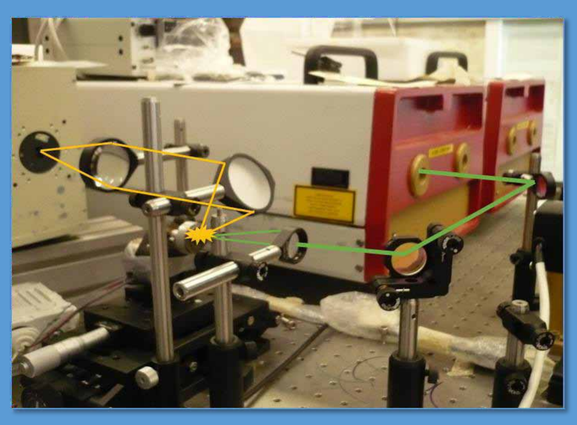
The LIBS Setup:

Q-switched Nd:YAG laser (Quanta System, model: Giant 770-10)

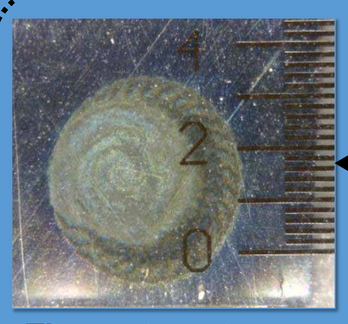
Monochromator 250nm/750 nm range, 1800 grooves/mm grating (Jobin Yvon Horiba TRIAX 550)

Intensified Charge Coupled Device (ICCD) (Jobin Yvon Horiba CCD-3000).

A digital delay/pulse generator (Stanford Research Systems model: DG535)



The laser pulse @ 1064nm was focused on to the target by a lens of (f:100 mm), the emitted light was reflected by an aluminum mirror(Ø:50 mm), the reflected beam was collected through a biconvex UV fused silica lens(f:75 mm) directly on to the monochromator entrance slit.

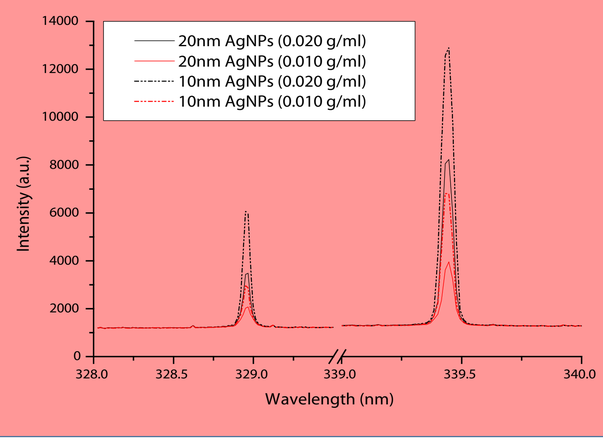


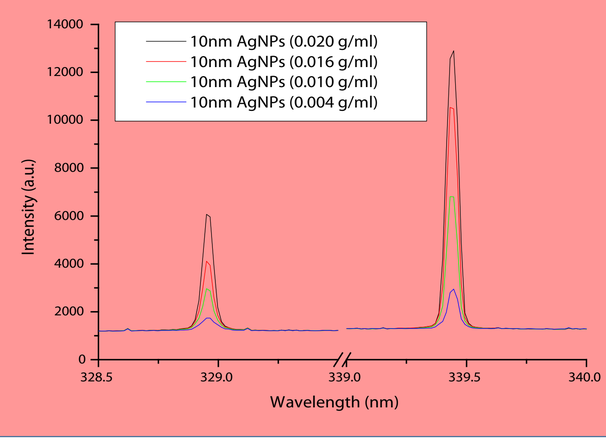
The target was rotated such that the laser spot coincides with the rotation axis and to ensure the laser spot to cover all the area contaminated by the NPs

- **Each emission spectrum was acquired in multi shot mode by averaging the acquired spectra taken from the rotating target.**

- **It was observed that Ag I emission intensity during LIBS of Ag NPs deposited on Si is linearly correlated with concentrations and dimensions of colloids.**

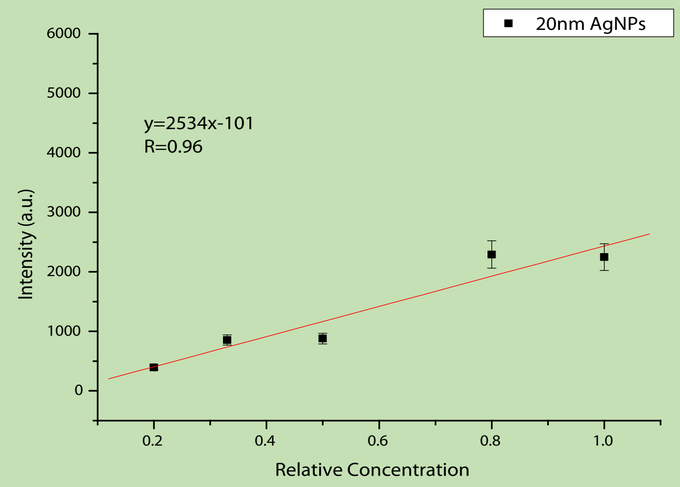
- **The LIBS signal of NPs appears to vary consistently with the change in concentration of the NPs, and to be affected as well by the particle size when the concentration of Ag atoms is kept constant.**

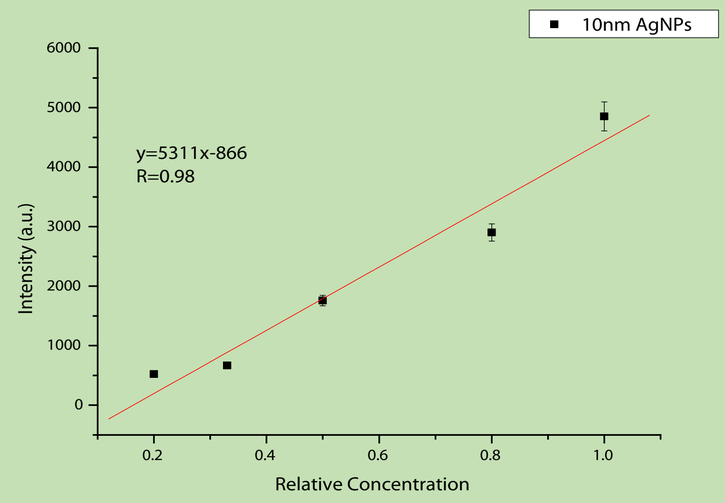


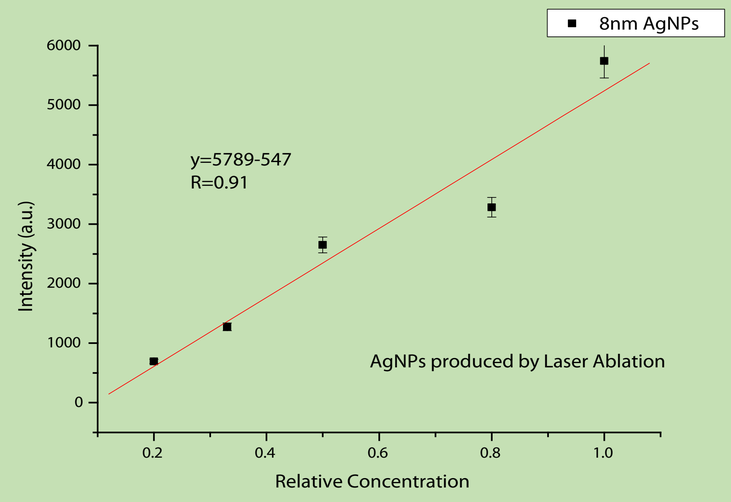


- **Highly reproducible calibration lines with a correlation factor close to unity were attained by using the standard calibration curve method [2].**

- **It has been found that slope is strictly dependent on the size of the NPs in the solution such that the average NPs size and their concentration have been determined with a limit of detection of few ppb.**







References:

[1] A. De Giacomo , M. Dell'Aglio , A. Santagata , R. Gaudiuso , O. De Pascale , P. Wagener , G. C. Messina , G. Compagnini andS. Barcikowski Phys. Chem. Chem. Phys.,15, (2013),3083-3092
[2] R. Gaudiuso, M. Dell'Aglio, O. De Pascale, G.S. Senesi, A. De Giacomo, Sensors 10 (2010) 7434-7468.

Acknowledgements

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