Laser Induced plasma spectroscopy coupled with Lateral Flow Immunoassay for advanced biological applications

M. Dell'Aglio[1*], H. Mateos[2], A. Mallardi[3], A. Taleb[2], G. Palazzo[2,1], A. De Giacomo[2,1]

[1] CNR-IFN (National Research Council - Institute for photonics and nanotechnologies), Bari, Italy
[2]Department of Chemistry, University of Bari, Italy,
[3]CNR-IPCF, (National Research Council, Institute for Chemical-Physical Processes), Bari, Italy,
[*]Corresponding author email: marcella.dellaglio@cnr.it

In this work, Lateral flow immunoassays (LFIA) and Laser-Induced Breakdown Spectroscopy (LIBS) were combined to acquire plasma emission spectra directly on the test line of the LFIA to quantify selected biomarkers. LFIA is a test based on the movement and selective blocking of the sample through a nitrocellulose membrane, and it is widely accepted for several biomarkers in the biomedical field (e.g. pregnancy or Covid tests). LIBS is the optical emission spectroscopy of the plasma produced with laser-matter interaction and allows a fast multi-elemental analysis of the irradiated portion of the sample. Moreover, employing plasmonic systems based on metallic nanoparticles (NPs) largely increases the LIBS sensitivity. This so-called nanoparticle-enhanced LIBS (NELIBS), allowing the emission enhancement up to two orders of magnitude and detecting trace elements at ppb level, has opened new scenarios in using LIBS for biological applications [1, 2]. Despite LFIA ease of use, it struggles with quantitative precision and multi-analyte detection. To overcome these limitations the coupling of LFIA and LIBS was employed to atomize metals directly on the test line of the LFIA, producing a LIBS spectrum of nanoparticles bound to the detection antibody and of all other metallic elements present in the sample, thus facilitating simultaneous analyte quantification. The aim is to quantify and recognize exosomes, extracellular vesicles (EVs) derived from a blood sample. The presence of tetraspanin proteins characterizes all the EVs cellular membranes. The conjugation of two different detection antibodies (Abs) with gold and silver nanoparticles (fig. 1) was tested in order to simultaneously detect and quantify the 3 membrane proteins from EVs trapped on a single test line. A detailed study of laser-induced plasma will be presented together with the study of the best plasma parameters useful to increase the detection of EVs. (*Funded by the European Union - Next Generation EU, Mission 4 Component 1 CUPB53D2302546 0001)*

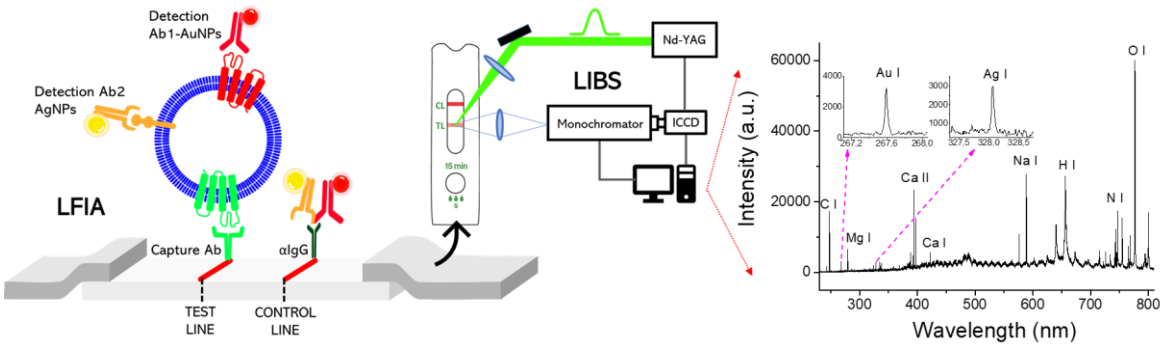

Figure 1. LFIA-LIBS to simultaneously quantify different membrane proteins on an extracellular vesicle and plasma emission spectrum.

References

[1] M. Dell'Aglio et al, ‚Spectrochim. Acta B 155 (2019) 115-122.
[2] M. Dell'Aglio et al, Talanta (2021), 235, art. no. 122741