Elemental imaging by Laser spectroscopy: new perspectives for biological and medical applications

Lucie Sancey[1], Benoit Busser[1,2,3], Florian Trichard[1], Frédéric Pelascini[4], N. Pinel[3], S. Roux[5], J-L. Coll[2], O. Tillement[1], J. Charles[3], V. Motto-Ros[1]

[1]InstitutLumière Matière, UMR5306 Univ. Lyon 1-CNRS, 69622 Villeurbanne, France
[2]Inserm U823-IAB, Univ. Grenoble Alpes, CHU de Grenoble, 38000 Grenoble, France
[3]CHU de Grenoble, 38000 Grenoble, France
[4] CRITT Matériaux Alsace,67305 Schiltigheim, France
[5] Institut UTINAM, UMR 6213 CNRS-UFC, Univ. de Franche-Comté, 25030 Besançon, France.

Contact: lucie.sancey@univ-lyon1.fr

Elemental imaging is very useful to image either labeled-free nanoparticle's, ortrace element,metals, and organic ions that play major roles in physiological and pathological processes. We recently developed an all-optical method, compatible with standard microscopy systems, for multi-elemental imaging of biological tissues. The proposed methodology is based on Laser Induced Breakdown Spectroscopy (LIBS) and allows the imaging and quantification of the elements of the periodic table in biological tissues, with ppm-scale sensitivity and a pixel size of up to 10x10 μm^2[1]. Samples of interest were screened using laser-induced plasma; the ablated matter is detected with spectrometers to elicit the specific optical response from inorganic elements naturally contained in biological tissues or administered in the form of metals. Elemental maps of are obtained by scanning the sample surface, and reconstructed.

We successfully applied this method to image and quantify the distribution of various nanoparticles in different organs. In particular, the renal elimination of gadolinium-based nanoparticles dedicated to theranostic approaches (*i.e.,* for both tumor diagnosis and therapy) was demonstrated[2].Gold nanoparticles were also observed after IV administration in the tumor of small animals[3]. Applied to human samples, this method allowed the identification of aluminum within a granuloma of the skin, after vaccination.

This laser spectroscopy technique is highly versatile because almost any element, especially metals, can be quantified with high sensitivity. Besides, this technique is fully complementary with standard optical microscopy, in particular with conventional gold-standard pathological and immunohistochemical analysis for diagnosis purposes. We describe the broad range of results obtained with LIBS for multi-elemental imaging of biological tissues for preclinical and medical applications, especially in the field of nanomedicine.

References

[1] Motto-Ros V., et al. (2013), Appl Lett, 101, 223702.
[2] Sancey L., et al. (2014), Sci. Rep.4 {doi:10.1038 /srep06065 - open access}
[3] Kunjachan S, et al. (2015), Nano Lett. Epub ahead of print