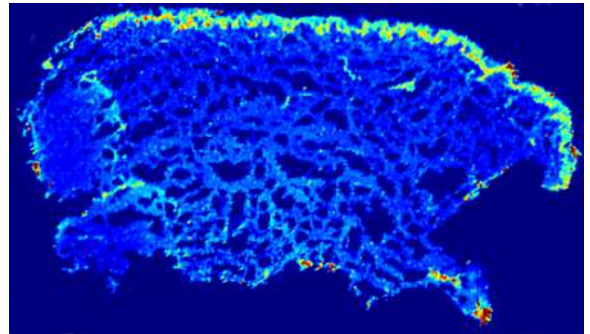


Application Note #MSI-14

Imaging of elements and metals in biological tissues

Multimaging platform and software is now able to study distribution of elements with Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) instrumentation



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Description of LA-ICP-MS

LA-ICP-MS Imaging (Laser Ablation Inductively Coupled Plasma Mass Spectrometry) is a recent technology that enables sensitive elemental and isotopic analysis to be performed directly on biological tissue samples. It has been used to study the distribution of gadolinium, calcium, potassium, lithium, iron, copper, zinc, gold, aluminum, platinum, etc.

LA-ICP-MS begins with a laser beam focused on the sample surface to generate fine particles – a process known as Laser Ablation. The ablated particles are then transported to the secondary excitation source of the ICP-MS instrument for digestion and ionization of the sampled mass. The excited ions in the plasma torch are subsequently introduced to a mass spectrometer detector for both elemental and isotopic analysis.

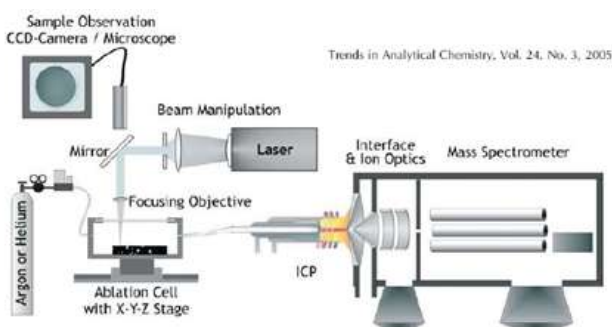


Figure 1. Schematic set-up of LA inductively coupled plasma mass spectrometry (LA-ICP-MS).

D. Günther, B. Hattendorf, *TrAC* (2005), 24(3), 255-265.

Figure 1. Presentation of LA-ICP-MS imaging concept from trends in analytical chemistry, vol 24, No 3, 2005

Benefits of LA-ICP-MS

- LA-ICP-MS can perform highly sensitive and quantitative tissue analysis without any sample preparation (picograms to femtograms).
- Similar to other Mass Spectrometry Imaging tools, LA-ICP-MS imaging allows
 - o Bulk analysis
 - o Local inclusion and defect analysis
 - o Depth profiling
 - o Elemental/isotope on tissue mapping
- The spatial resolution is generally between 1-350 μ m depending sensitivity.

Example in dermatology

Calcium is an important endogenous element that serves in every cell and many functions of the organs (muscle, brain, blood, etc.). In skin, calcium has been described to regulate several key physiologic events including epidermal proliferation, differentiation and cell—cell adhesion. Disruption of Calcium regulatory pathways can lead to calcification and ossification of the skin. Here we present a first example of Calcium detection and localization on a skin sample with different concentration from the epidermis and dermis. The 20 μ m spatial resolution showing 225 000 pixels in the image with a higher concentration in the epidermis compared to the stratum corneum and the dermis.

The concentration has been evaluated at 20-40 $\mu\text{g/g}$ and 8 $\mu\text{g/g}$ of tissue for the epidermis and the dermis respectively.

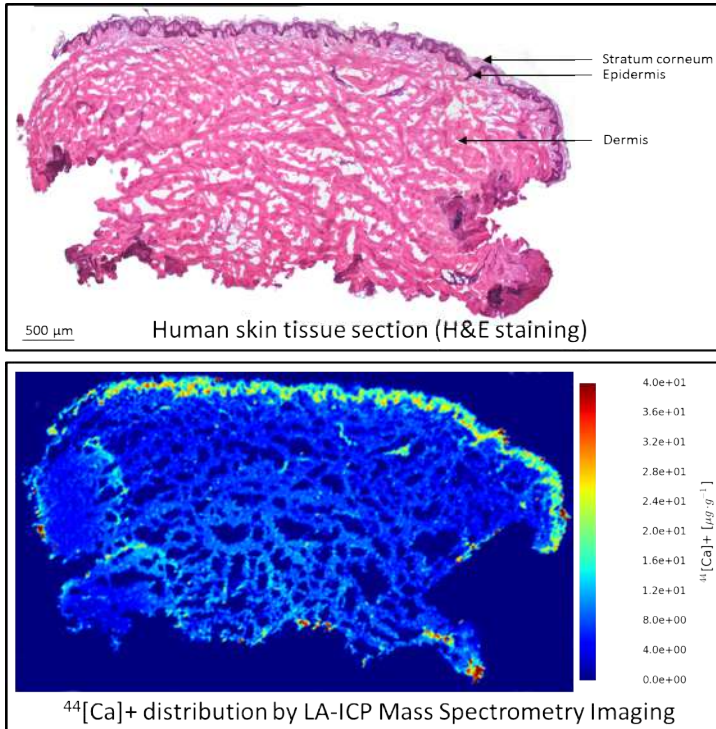


Figure 2. Distribution and quantification of calcium in Human skin tissue at 20 μm resolution by LA-ICP-MSI ©Galderma

Example within the brain with contrast agent imaging (Complex of gadolinium)

Gadolinium complex are the most reliable MRI (Magnetic Resonance Imaging) contrast agents on the market. These contrast agents in combination of MRI instruments help to visualize organs, anatomy and physiology. In this second example, we can study the Gadolinium distribution within the brain tissue, after Intra venous mouse dosing. Animal has been prepared through Fast Frozen process to keep intact morphology and analysed with LS-ICP-MS imaging process. In this study, the gadolinium has been detected in all the brain tissue with different concentrations (bregma 11.28mm). The higher concentration of Gadolinium complex is localized in different ventricles (especially the 4th ventricle). Interestingly, 4 different regions present the gadolinium (Sup cerebellar peduncles, Granule cochlear, Interposed anterior, Lateral cerebellar parvicell and lateral cerebellar nuclei). Moreover, gadolinium complex seems to follow the white and grey matter histology. Regarding concentration, Gadolinium has been detected from 50ng/g to 500ng/g of tissue.

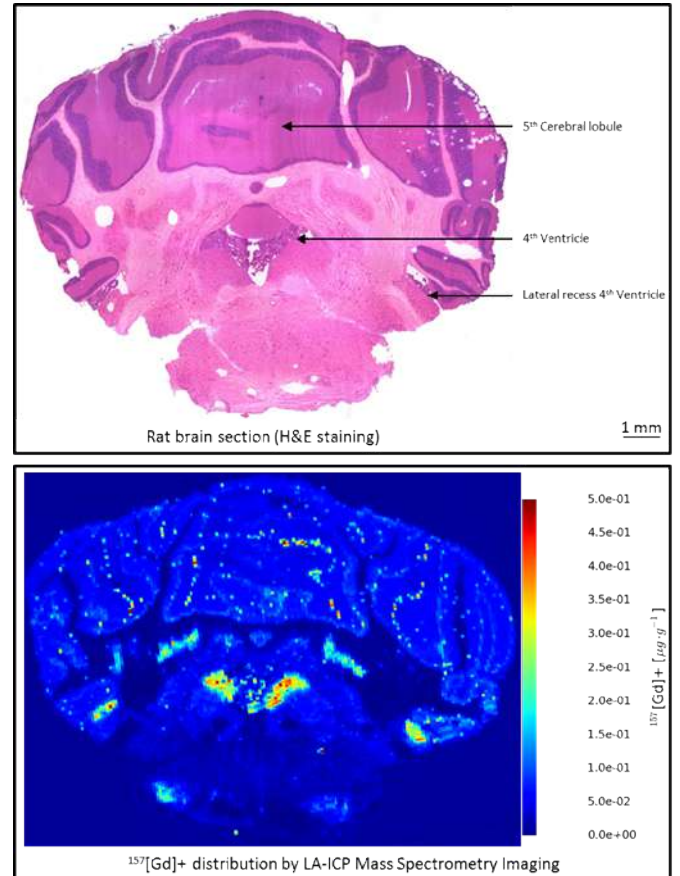


Figure 3. . Distribution and quantification of gadolinium in rat brain coronal section at 80 μm resolution by LA-ICP-MSI

Conclusion

LA-ICP-MS imaging is really interesting to investigate elemental analysis. This is a complementary technique that has been added to ImaBiotech's platform of Multimaging. With Multimaging software, it is also possible to overlay ICP images with other MALDI, DESI, LESA Mass Spectrometry Imaging and immunohistochemistry images at cellular level. This makes a reliable set of tools and software to support your investigation.

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