Application Brief

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# Study of Localization of Endogenous Metals on Thin Tissue Sections by LA-ICP-MS

## Multi-element analysis of biological samples using laser ablation with an Agilent ICP-MS


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## LA-ICP-MS provides bioimaging and metallomics data

Bioimaging and metallomics are complementary fields of study that explore the role of analytes and metals in biological systems. Bioimaging visualizes the presence or absence of certain tissues, cells, and low molecular weight compounds while metallomics seeks to understand the functions and roles of metals in biological structures. Analytical techniques such as liquid-chromatography-inductively coupled plasma-mass spectrometry (LC-ICP-MS), single cell-ICP-MS, and laser ablation (LA) ICP-MS have been used for protein quantification[1], single cell analysis[2], and bioimaging, respectively.

LA-ICP-MS can provide detailed information about the localization of elements on the surface of solid samples, as demonstrated in this study for the investigation of the distribution of metals on thin sections of biological samples.

## LA-ICP-MS instrumentation

In separate studies, an Agilent 8900 ICP-QQQ and Agilent 7900 ICP-MS were coupled with an ESL213 Laser Ablation System (Elemental Scientific Lasers, Bozeman, MT, USA). The LA system was controlled directly from the Agilent ICP-MS MassHunter software via the ESL-developed ActiveView2 (AV2) plug-in for ICP-MS MassHunter (Figure 1), enabling fully integrated sample analysis.

## Distribution of metals in heart samples

Myocardial infarction (MI) is induced by thrombosis or obstruction in the coronary arteries. In the chronic phase, referred to as old MI, the myocardium undergoes fibrosis, evident as blue areas in Azan staining—see Figure 2a. Also, concentrations of $^{31}P$, $^{44}Ca$, and $^{56}Fe$ determined by LA-ICP-MS using the 8900 in $O_2$ mass-shift mode decreased on the left-side area compared to other regions – see Figure 2 (b to d). The results from the two complementary techniques showed that metal distribution information obtained by LA-ICP-MS can serve as an indicator of cell viability in the tissue.

## Characteristic localization of metal proteins in mouse liver

A 10 µm thin section of C57BL/6 mouse liver was analyzed by LA-ICP-MS using the 7900 in $H_2$ and He mode. The images in Figure 3 show the presence of $^{95}Mo$, $^{98}Mo$, and $^{56}Fe$. $^{95}Mo$ and $^{98}Mo$ show a similar pattern, demonstrating the reliability of the method. The molybdenum signals suggest that the isotopes accumulate in the liver and exist as molybdopterin cofactors. The $^{56}Fe$ signals mainly surround a blood vessel at the center bottom of the sample, which aligns well with the observed red blood cells, suggesting the existence of heme iron (Figure 3c). The superimposition of Figures 3a and 3c reveals that $^{56}Fe$ and $^{95}Mo$ are detected in distinct regions (Figure 3d), suggesting a characteristic localization of metal proteins in tissues.

## LA-ICP-MS instrumentation

The study demonstrates the high performance of fully integrated Agilent and ESL LA-ICP-MS systems for bioimaging of thin sections. The data provided useful insights into metal accumulation resulting from tissue lesions, and characteristic localization of metal proteins and cofactors in tissues.


**Figure 1.** The Run Queue tab and status panel of the ESL213 LA system displayed in Agilent ICP-MS MassHunter software via the ESL AV2 plug-in.

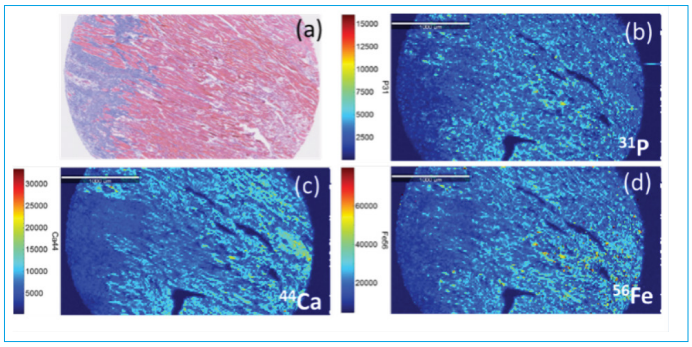


**Figure 2.** (a) Azan staining of human heart. (b to d) Distribution of analytes on thin sections of heart determined by LA-ICP-MS. Scale: 1000 µm.

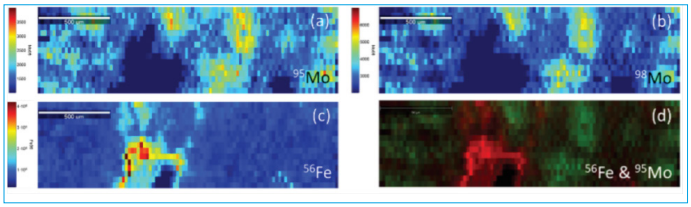


**Figure 3.** (a to c) Distribution of $^{95}Mo$, $^{98}Mo$, and $^{56}Fe$ by LA-ICP-MS. (d) Red Green Blue (RGB) mode image produced by iolite 4 software (ESL), which combined $^{56}Fe$ (red) and $^{95}Mo$ (green) data into one image. Scale: 500 µm.

## References


1. Jiménez Nosti, A. et al., Direct and Traceable Mass Purity Certification of Protein Standards using LC-ICP-MS/MS, Agilent publication, 2022, 5994-5073EN
2. Tanaka, Y.et al., Evaluation of the Elemental Content of a Single Cell using Fast Time Resolved Analysis (TRA) ICP-MS, Agilent publication, 2022, 5994-4460EN


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