High-Speed Elemental Imaging of Cisplatin-Perfused Tissue with Laser Ablation-icpTOF

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icpTOF

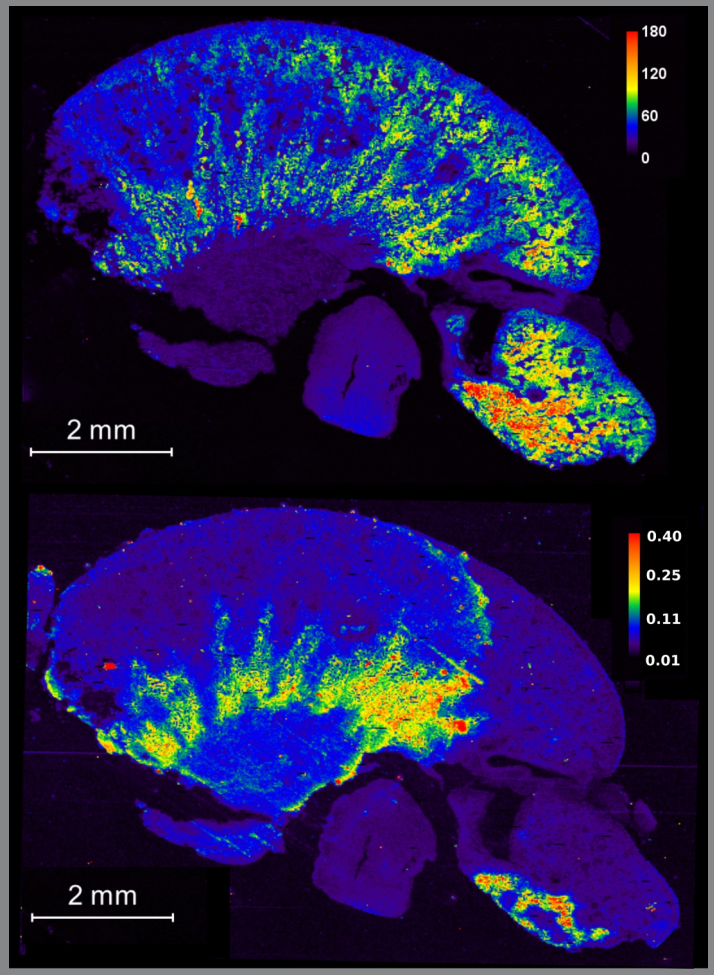
Despite extensive progress in anti-cancer drug development, Pt-based compounds remain the most frequently used anti-tumor agents for chemotherapy. Understanding drug distribution, accumulation and metabolism is important in order to optimize Pt-based treatments and minimize side-effects.

Laser ablation (LA) ICP-MS imaging of Pt in tissue has received significant attention over the last decade due to the method's low detection limits and quantification capabilities. But, routine use of the technique is limited by the extensive time required for analysis. With the standard instrumentation it takes almost 30 hours to image a 5 mm^2 area with lateral resolution of 15 µm (e.g., JAAS, 2012, 27, 159-164).

When coupled, the icpTOF and recently developed fast laser ablation systems significantly increase imaging speed without compromising sensitivity or lateral resolution. Image blurring is minimized by synchronization of the laser and mass spectrometer on a single-laser-pulse basis.

This work shows an example of Pt-imaging in a thin section of a rat kidney that was perfused with Cisplatin, a Pt-containing chemotherapy medication. A 10 x 7 mm tissue section was imaged, with all elements recorded, in 5 hours. Higher Pt concentrations were detected in the cortex region compared to the medulla and pelvis due to the presence of the proximale tubuli cells in this region. Maps of other elements, such as Cu, might provide additional information about the sample.

The combination of the icpTOF and fast laser ablation systems performs all-element imaging at much higher speed than standard LA-ICP-MS instrumentation – making it practical to routinely image large areas of tissue.



Cu intensity map (bottom) and Pt concentration map (top) of 5-µm thin section of a rat kidney, perfused with Cisplatin. Ablation was performed at 20 Hz laser frequency, with a 20 µm square laser spot size, 2 J/cm^2 fluence and scan speed of 200 µm/s. At this scan speed 10 laser pulses were applied to every 20 µm spot and 10 signals of single laser pulses were averaged to produce the signal of one pixel. Pt was quantified using external calibration with a series of in-house (University of Münster) produced element standards embedded in Technovit.

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