COVALENT METROLOGY

Covalent Academy Episode 30 Q&A

Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICPMS): Not Just Rocks

Presented By: ***Lucas Smith***

Director of Business Development for the Americas, Teledyne CETAC

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01

Q: What is the typical spot size?

(Answer provided by Damon Green during webinar)
Spots are typically less than 100 um, often 20 um or less in these applications. Note that smaller spots are possible, even down to 1um, but the amount of material removed for analysis is also reduced so you also need to consider how this affects sensitivity on your ICP.

02

Q: All of these images are amazing - how much LA has improved in a relatively short time! What is the cell wash-out time?

(Answer provided by Damon Green during webinar)
Cell washout time is variable. We can optimize from over 1 second to a full pulse sent through the system in 1ms simply by modifying gas flows and adding a piece or two of glassware on the back of the ICP torch.

03

Q: Are there any applications for multilayer food packaging materials?

(Answer provided by Damon Green during webinar)
Multilayer food packaging - If you are interested in elemental concentration in layers of plastic then a laser system can either analyze each layer in turn by gently rastering the surface, or by drilling a hole and removing material with each laser shot. Each individual laser shot would remove only a few nm of material. The success, or otherwise, of this application would depend on what needs to be measured and at what concentrations, but in principle it should be possible.

04

Q: Can laser ablation be used for determining metals levels in a liquid solution by measuring the solid residues left behind from evaporation to dryness? If so, how would possible nonuniformity of precipitated solids be handled and what would the detection limits be? Would concentration of the initial solution impact detection limits?

Answer: The short answer is yes, it can. LA ICP MS has been successfully used in the past for the analysis of dried blood, serum, wine, beer, coffee, etc. There's in fact a paper titled "Radial line-scans as representative sampling strategy in dried-droplet laser ablation of liquid samples deposited on pre-cut filter paper disks" which discusses various protocols to be used in order to make sure that the ablation of a dried liquid droplet is representative of the chemical composition of the solution used. Naturally, the initial concentration of the dried solution is essential in establishing the limits of detection and quantification, but since the modern laser ablation systems can quickly ablate large areas, one can fully ablate an entire dried droplet in a matter of seconds to minutes, hence increasing the amount of sample that is delivered to the ICP to be measured. With the appropriate hardware and a well developed analytical method, the LOD can be in the single digit ppm range, and even below that in some cases.

05

Q: What are the upper limits on sample size? About how big is the smallest sample that can be measured?

Answer: The sample chamber itself measures 100mm x 100mm and allows for the placement of a modular drawer design that can be outfitted to meet your specific sample needs. One of the insert options is an open chamber that allows for the placement of larger samples and measures 100 mm x 2.75" (~69.85mm).

06

Q: How shallow can you make the crater? Any possibility to have nm depth?

Answer: The depth of the ablation craters are ordinarily measured in nanometers as each “shot” of the laser results in nanometers of material being removed. How much material is dependent upon a number of factors such as the ablated matrix and the power with which the laser is operating. On the other end of the spectrum, the crater depth can increase to ~3x the width of the crater. Beyond that depth, the ejected material begins to have trouble escaping the crater and often times hits the wall and falls back to the bottom to be re-ablated. This can have serious ramifications on data quality.

07

Q: Is sample prep other than mounting with an epoxy resin and polishing applicable? How would non-epoxy mounted samples fit within the ablation cell?

Answer: Traditionally, samples have been mounted within an epoxy resin and polished to provide a flat surface but this is largely because laser ablation was a geo-centric tool in its infancy. Other sample mounts are certainly possible including the use of thin section mounts, glass slides for biological sample analysis and even an open chamber that allows for the placement of larger or irregularly shaped samples that the user may not wish to mount or polish (e.g. meteorites or archeological samples). These irregularly shaped samples are sometimes placed within the open sample chamber using a piece of putty or the placement of glass beads/sand in the bottom of the drawer to help with placement and also help eliminate unnecessary dead-volume.

08

Q: Are the maps quantitative? Does each pixel contain quantitative data for every element?

Answer: Yes. LA-ICPMS is a fully quantitative technique and, when performing mapping applications, each pixel (in all three directions) contains all of the elemental data acquired by the ICPMS. Of course, it being quantifiable depends upon the quality and matrix-match of the utilized standards but, rest assured, Teledyne’s HDIP software provides an automated solution to perform the quantitation and interrogate the data.

09

Q: Can LA ICPMS perform the chemical/elemental analysis on zinc-based, lead-based metals, galvalume? Can LA ICP MS perform the coating elemental analysis of galvanized and galvanneal samples?

Answer: A single laser pulse can remove a few nanometers to tens of nanometers from a sample's surface, depending on the laser used and how the lasing parameters are selected. This means that LA ICP MS is well suited for the analysis of coatings and thinly deposited films. We have quite a few users around the world who are routinely performing paint analysis on different matrices (metal, glass, ceramics, polymers) as well as various other coatings applied on metals and polymers.

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Q: What is the lightest element the LA-ICPMS can detect? What is the detection limit for that element?

Answer: Lithium is the lightest element that can be reliably measured using LA ICP MS techniques. The limit of detection is largely dictated by the ICP MS used in conjunction with the laser, but certainly the laser can provide enough sample for a sensitive ICP MS instrument to be able to measure Li in below ppm range.

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Q: You mentioned some possible [elemental] Standard providers, but I didn't quite catch the name of the German company. Could you remind me what it was called?

Answer: The name of the company is myStandards GmbH. They can be found at the following URL: https://www.my-standards.com/en/.

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Q: Is LA-ICPMS considered a destructive technique?

Answer: Technically the answer is yes although only on a micro-scale. As the typical spot used for ablation is 50um, or less, the vast majority of most samples is still available for analysis by other techniques. The exception to this is with biological samples which are ablated from a glass slide and often ablated in their entirety in order to maximize sensitivity.

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Q: Sorry if I missed your mentioning this, but can LA-ICPMS be performed on liquids? If that's possible, how reliable are the results?

Answer: The short answer is "yes" although there are a number of considerations to be made. The more thorough answer would be that although it's possible to ablate liquids, LA-ICPMS is seldom the best analytical tool for their analysis and would likely be a costly, and less accurate technique

than others available. In the event that you have a sample type that you think would benefit from the technique or you have other reasons for wishing to determine if LA-ICPMS may be a good fit for your analysis, the team at Photon Machines is always happy to discuss and offer advice as to applicability.

