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Laser ablation elemental analysis gas source IRMS. Quick, easy, and accurate results.

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Laser ablation techniques allow high-resolution sampling with robust accuracy and precision, notably in materials where conventional sample preparation is difficult like tree rings and other heterogeneous organic materials. Laser ablation coupled with gas-source IRMS can enable high spatial resolution sampling in a broader range of sample types, but these implementations have historically required substantial in-house hardware modifications such as custom flow paths and non-standard interfaces. In recent years, commercial companies have begun to address this demand by offering more integrated, standardized workflows.

Here we present a demonstration laser ablation–EA–IRMS workflow. The system consisting of ESL213 laser ablation system (Elemental Scientific Lasers, Bozeman, MT) equipped with a novel IRMS optimized sample cell, coupled to a Thermo Scientific™ DELTA™ Q gas-source IRMS with EA IsoLink™. In this configuration, ablated material is transported as follows: laser cell → EA IsoLink → ConFlo IV → DELTA Q IRMS. This approach effectively replaces the EA autosampler with automated laser-shot sequences, preserving the proven benefits of EA-IRMS while also enabling high spatial resolution sampling and rapid, low-preparation analyses.

For $\delta^{13}C$ measurements of organic materials, the system can be operated with or without cryofocusing. Across representative materials (e.g., tree rings, pressed powders, and keratin such as fingernails), we observed external precision better than 0.1‰ and accuracy assessed by VPDB normalization (scale-correction standard error) better than 0.2‰. Spot size and laser parameters are adjusted based on material type and target uncertainty. For wood, <0.2‰ accuracy was achieved using single-stage cryofocusing with a 45 µm spot size, ~5 J cm^{-2} fluence, a 4 s dwell time, and a 20 Hz repetition rate. To achieve comparable data quality without cryofocusing, the spot size was increased to 250 µm.

Typical analytical cycle times are <3 minutes without cryofocusing and ~5 minutes with cryofocusing, corresponding to ~20 and ~12 spots h^{-1}, respectively (exclusive of sample changes). The laser cell's push-to-seal fittings enable rapid sample exchange, with backgrounds returning to runnable levels in <5 minutes. Recent laser-cell improvements also enhance aerosol transport at helium carrier gas flows rates preferred for IRMS operation (30–90 mL min^{-1}), with no detectable carryover between samples.