

Why go shorter? Design, Rationale and Performance of a Custom-built Dual-Wavelength (157 & 193 nm) Cryo-LA-ICP-MS/MS System

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Over the past ~30 years laser-ablation plasma mass spectrometry (LA-ICPMS) has become the most versatile technique for spatially-resolved elemental and isotopic analysis. Important LA developments included the move from ns to fs pulse lengths, besides the gradual decrease in laser wavelength (IR-UV) and key developments in LA cell design [1].

Besides pulse length, ultrashort wavelengths beyond the ‘unofficial LA community standard’ of 193 nm (ArF excimer lasers) have received scant attention. However, utilizing F₂ as emission molecule, there is an even shorter excimer wavelength at 157 nm, and there are good reasons for using LA at 157 nm. These include much improved absorption at 157 vs. 193 nm for important materials, coupled with the ~20% higher photon energy at 157 vs 193 nm. Owing to the strong attenuation of 157 nm radiation in air and at optics combined with the >10-fold lower energy output of laser sources at 157 vs. 193 nm, 157 nm LA is technically challenging [2].

Here, we present our attempt of rekindling 157 nm LA. We have established a custom-designed Dual-Wavelength LA System featuring two separate laser sources operating at 157 nm and 193 nm, based on a modified RESOLUTION-SE LA system. Given that one application represents direct ablation of frozen glacial ice to retrieve dust aerosol compositions, it also includes a 2nd generation cryo-holder [4], compatible with the S-155 Laurin LA cell that accepts ~50 cm of ice core length. The rationale for ice ablation at 157 nm is the ~8 orders of magnitude greater absorption at 157 nm than at 193 nm [3]. Our LA system design is modular, allows the 157-193 nm changeover with minimal hardware modifications and facilitates direct experimental comparison between the two wavelengths.

At 157 nm, we demonstrate highly-controlled ablation of natural and artificial ice besides other ‘difficult-to-ablate’ materials such as natural quartz, Ca-sulphates or fused silica glass.

[1] Sylvester PJ & Jackson SE: *Elements* 12, 307-310, 2016

[2] Telouk P et al.: *Geostandards Newsletter* 27, 5-11, 2003

[3] Warren SG & Brandt RE *Journal Geophys. Res* 113, D14220, 2008

[4] Müller W et al.: *JAAS* 26, 2391-2395, 2011