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INNOVATION TO ILLUMINATE

Poster Note

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Analytical Performance of a Turnkey Femtosecond Laser Ablation System

Introduction

Much has been made of the capability of femtosecond laser ablation ICPMS to reduce fractionation in analysis through extensive research to the point where a commercial market now exists for off-the-shelf femtosecond laser ablation systems such as the NWRfemto (now ESLfemto) from Elemental Scientific. Here we present research performed using Elemental Scientific's NWRfemto laser systems using peer reviewed work on matrix dependency of multistandard analysis from the Max Planck Institute (Mainz, Germany) and zircon analysis and particle distribution analysis from the University of Kyoto (Japan).

Improved precision in zircon analysis by femtosecond laser ablation

Geochronological analysis of zircons is a key application where improvement has been suggested through the implementation of femtosecond lasers since the low thermal component of the ablation process should reduce boiling of volatile Pb from the sample relative to U. The following data, supplied by the University of Kyoto and acquired using a NWRfemto, demonstrates zero fractionation due to heating, zero down-hole effect due to the smaller particle size distribution and excellent precision of multiple analyses in generating concordant data (Figure 1).

Pulse-width dependence of particle size distribution

Further studies from the Kyoto group have highlighted a phenomenon that has a great bearing on fractionation of analysis in common materials list NIST610. While, on average, the particle size distributions (PSD) generated by fs and ns ablations are broadly similar it was found that the PSD of ns ablations shifts throughout a down-hole ablation, such as is used in most geochronology experiments, while the PSD for fs ablations remains the same. Figure 2 highlights this data. An additional study on pure Ni metal demonstrated that, while the PSD's were the same for both fs and ns lasers the particle count for fs was around a factor of 20 higher (Figure 3).

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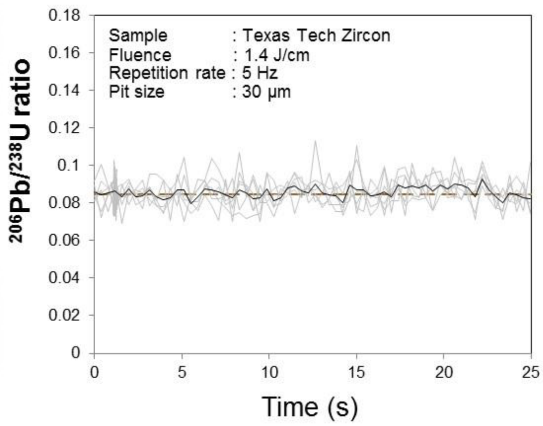

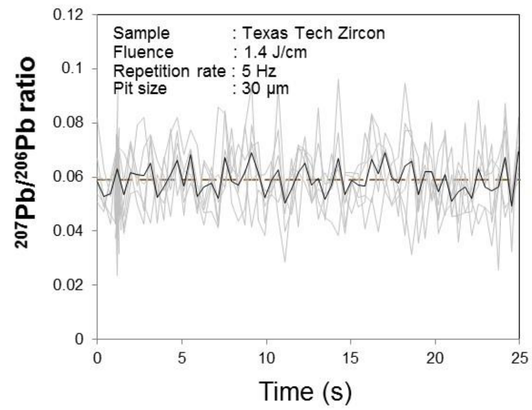

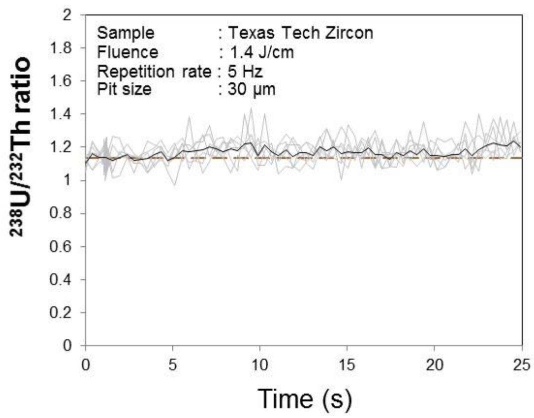

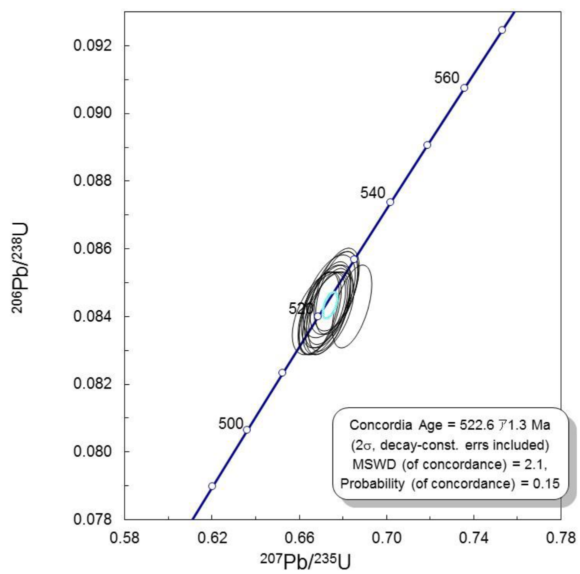

Figure 1. Results of U/Pb geochronology experiment on a zircon performed using a NWRfemto femtosecond laser ablation system.

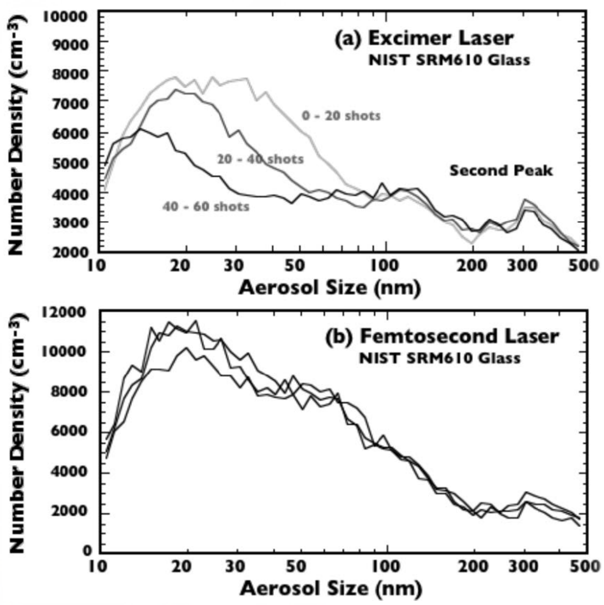

Figure 2. Time-dependent particle size distribution resulting from ns and fs ablation of NIST610. fs ablation shows no fractionation.

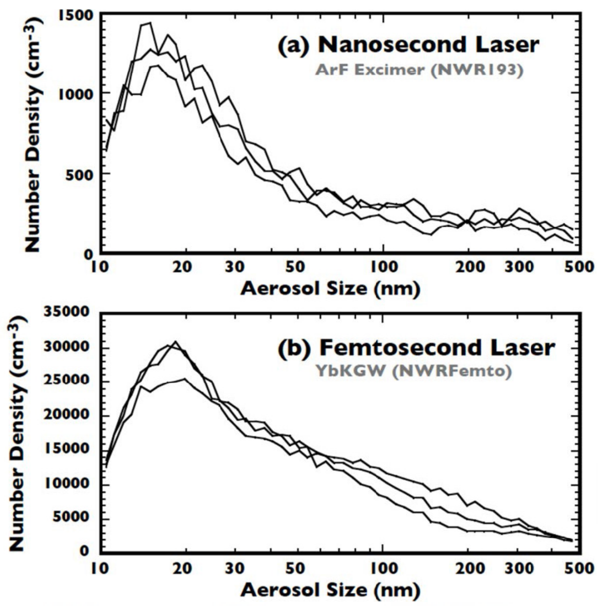

Figure 3. Particle size distribution resulting from ns and fs ablation of pure Ni metal. fs ablation gives 20x the particle count.

Reduced matrix-dependency with femtosecond laser ablation

The Max Planck Institute for Chemistry (Mainz, Germany) performed the most comprehensive assessment of matrix dependency of nanosecond and femtosecond laser ablation to date in a study using 22 certified reference materials ranging from silicates to carbonates to phosphates. The study involved direct comparisons of data from a NWR213 (now ESL213), a NWR193 (now ESL193) and a NWRfemto 200nm. A selection of the data from this study is presented as fractionation factors (Figure 4) and Element/Ca ratios (Figure 5). It can be seen that, especially for volatile/non-volatile ratios like Rb/Ca femtosecond offers a distinct improvement since the thermal component of the ablation is significantly reduced compared to nanosecond laser ablation. Figure 6 demonstrates matrix dependency of the ablation process by sample-type and element-type for each laser.

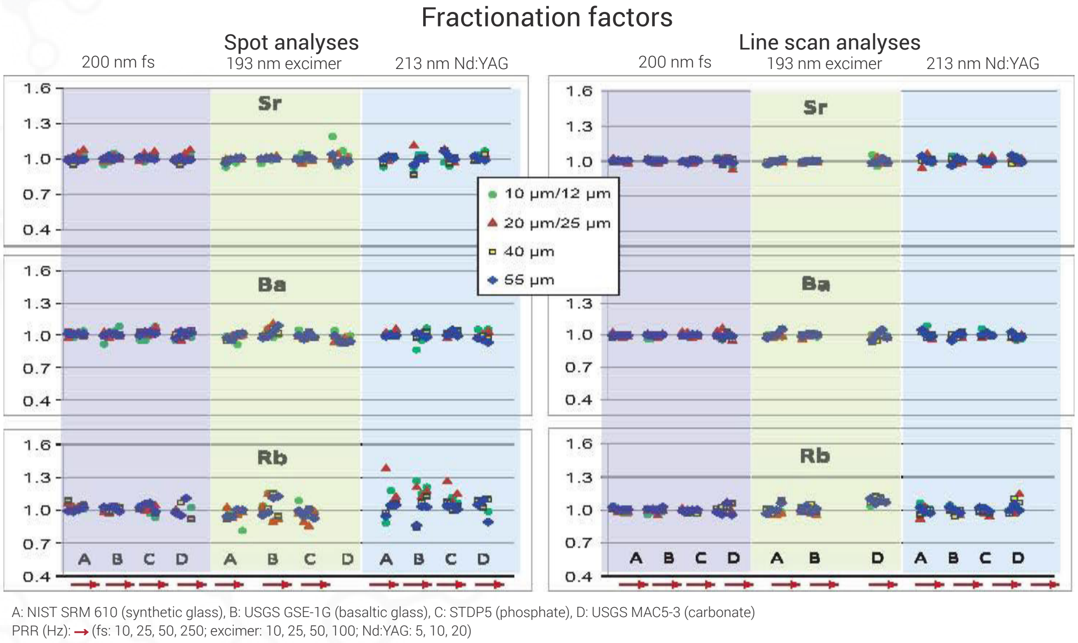

Figure 4. Time-dependent particle size distribution resulting from ns and fs ablation of NIST610. fs ablation shows no fractionation.

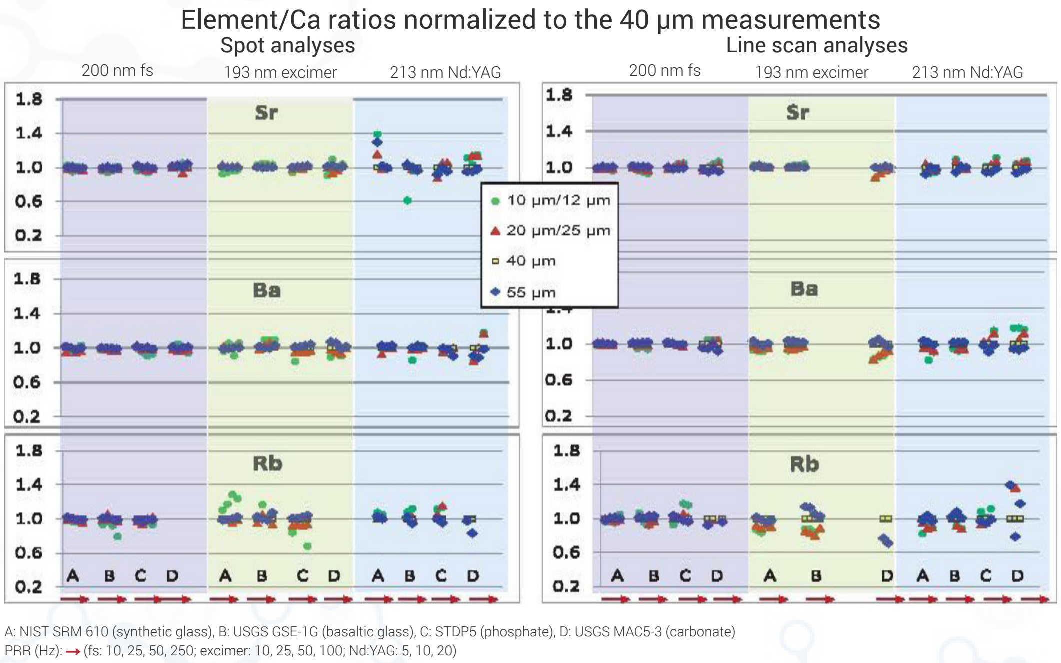

Figure 5. Element/Ca abundance ratios of seven elements obtained from investigation of four different reference materials with different matrices (NIST SRM 610, USGS GSE-1G, STDP5, USGS MACS-3) using 200 nm fs, 193 nm excimer and 213 nm Nd:YAG LA.

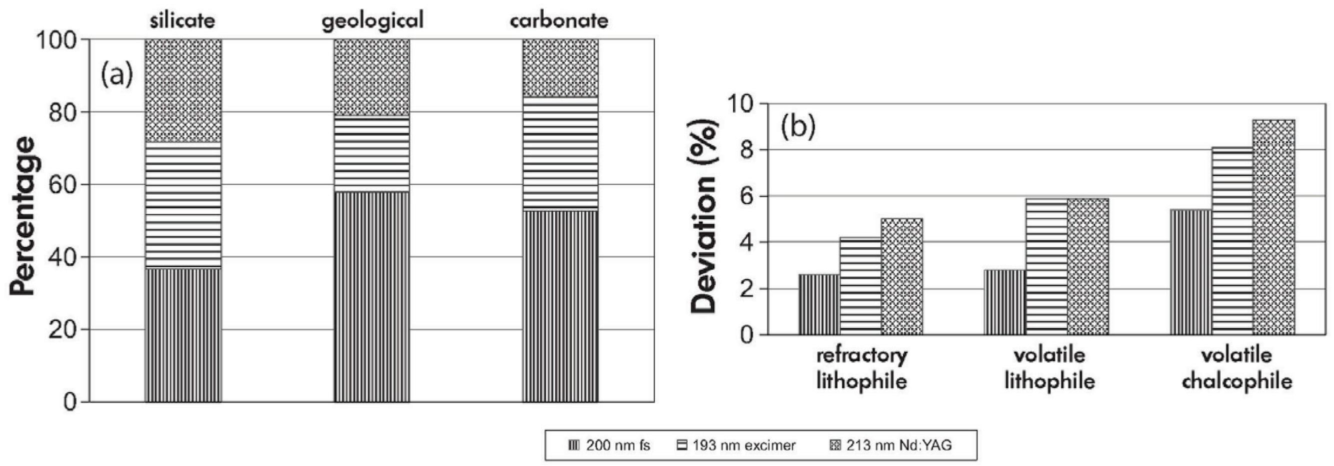

Figure 6. (a) Mean percentage of analytical data obtained by 200 nm fs, 193 nm excimer and 213 nm Nd:YAG LA, which agree best with the reference values. (b) Mean deviation of analytical data from reference values.

Conclusions

The NWRfemto is the smallest and most robust turnkey laser ablation system available today, and combining this with the proven benefits of ultra-fast UV lasers delivers a real and reliable return on investment.

Acknowledgements

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