UP 193 Solid-State Laser Ablation System

Not including cart

An all-purpose, solid-state 193nm system without compromise

- The next step towards matrix-independence from one system, one wavelength, one company
- A dedicated 193nm LA-ICP-MS solution that ablates all materials equally well, from quartz to metals
- Unmatched irradiance generates consistently small particles for efficient ionization and long steady signals
- The short pulse length and deep UV wavelength provide excellent depth profiling to < 50nm/shot

A state-of-the-art design from a leading laser company

- A sub 3ns pulse ablates all materials without the thermal effects seen with long pulse excimer designs
- Sub 2μm and larger aperture imaged spots; select from 13 pre-calibrated sizes
- Unmatched efficiency and simplicity ensure high reliability and a low cost of ownership
- Active crystal heating and closed-loop tuning delivers stable, drift free operation
- World-wide support by laser technicians and LA-ICP-MS specialists

NEW WAVE™ RESEARCH

Specifications

The UP193 Solid-State

New Wave™ Research introduces a fit-for-purpose solid-state, 193nm laser ablation system. Operating in the deep UV, at very short pulse widths optimal performance can be obtained for all sample types. The UP193 is designed for the most rigorous LA-ICP-MS requirements and delivers unequalled performance day after day.

This breakthrough technology yields more output from less input, using the fewest, most efficient components. The UP193 is pumped with the same special-edition Tempest laser and controlled by the same feature-rich Universal Platform software found in our UP213, the most popular system in the industry.

The proprietary laser design and beam conditioning were engineered to deliver uniform, precision craters with optimal stability each and every time.

The UP193 offers a full compliment of analytical tools including auto-sampling, sample-mapping and other unique features for in-situ and bulk analysis.

The UP193 can be displayed on a second monitor simultaneously with the MS software from the same computer. Compatible with all makes and models of ICP-MS instruments.

Primary Specifications

Laser	Solid-state 193 internally homogenized, flat beam
Energy control	Continuously variable 2-element optical attennuator
Stabilization	Active crystal heating and closed loop tuning
Pulse length	< 3 ns
Maximum Repetition rate	10Hz— single, burst and continuous modes
Spot selections	12, all aperture imaged; from 2µm to 110µm
Irradiance @ sample	>2 GW/cm² (aperture imaged)
Fluence @ sample	>5 J/cm² (aperture imaged)
Color Video Microscope	2 µm feature resolution
X-Y Stages	52X52mm travel; 0.25um resolution
Stage configuration	Open architecture with viewing shield, no enclosure
Sample chamber	Quick-change drawer; 52mm ID X 52mm deep
Objective lens	25mm travel; 0.25um resolution
Safety classification	Class 1

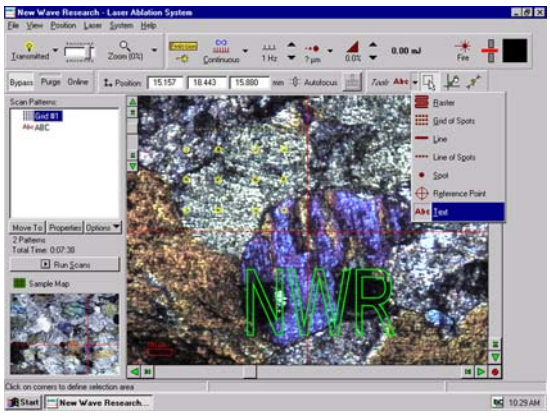
Site requirements

Laser Ablation System

25x18x22” / 64x46x56 cm (L,W,Height to trinocular option eyepieces); 150 lbs/ 68 kg
100-110VAC, 3A / 220-240VAC, 2A ; 50/ 60Hz

Power Supply

19x8.6x15”/ 48x22x38 cm (L,W,H); 55 lbs/ 25 kg 100-110VAC, 10A / 220-240VAC, 5A; 50/ 60Hz .



SOFTWARE

Options

- Trinocular microscope
- Auto-focus
- Helium mass flow controller
- Glitter data reduction software
- Specialized sample chambers

Support

- New Wave™ Research, a laser manufacturer, is the leading supplier of laser systems for elemental and isotope analysis.
- New Wave™ Research provides global support and services by laser specialists via its regional offices in U.S., Europe, Japan, China and Taiwan.
- The Universal Platform (UP) series which includes the UP266, UP266MACRO, UP213 and UP193, is a proven design and industry standard instrument for LA-ICP-MS.

Application

Within the last 10 years fundamental research investigating the effect of wavelength, fluence and pulse width on laser material interaction and subsequent aerosol transport to an ICP Spectrometer has led to the conclusion that deep UV, short pulse width systems offer the greatest advantages, especially for the analysis of silicates and other geological materials. With the implementation of the 213nm solid state and 193nm excimer systems in the mid 1990s and now with the UP-193nm Solid State system, with its short sub 3ns pulse width, commercial laser ablation systems continue to evolve to support the needs of the analytical community.

Background

The ability of a laser to couple effectively and transfer its photon energy directly to the sample matrix is critical for accurate and precise analytical micro-sampling. Losses due to transmission of the laser light through the sample or conversion of the photon energy into heat, dissipated into the sample lattice, should be kept to a minimum.

The relationship between absorbance of laser energy into the sample matrix and improved analytical results has been understood for some time.[1] Absorption of laser light into a silicate matrix is enhanced as one goes to shorter wavelengths (Fig. 1).

Geersten and colleagues [2] and Jefferies and colleagues [3] compared the fundamental Nd:YAG wavelength, 1064 nm, with its fourth harmonic at 266 nm. They found that shorter UV wavelengths displayed improved ablation characteristics. In 1997 Gunther et al [4] published a paper based on work with an optically homogenized excimer laser, operating at 193 nm. They found that the benefits afforded by the short wavelength were well suited to geochemical applications. These excimer, gas lasers however are larger, more expensive, and involve replacement of ArF gas. In 1998 Jefferies et al [5] compared the solid state Nd:YAG fifth harmonic at 213 nm with the fourth harmonic at 266 nm and found a further benefit using the shorter 213-nm wavelength.

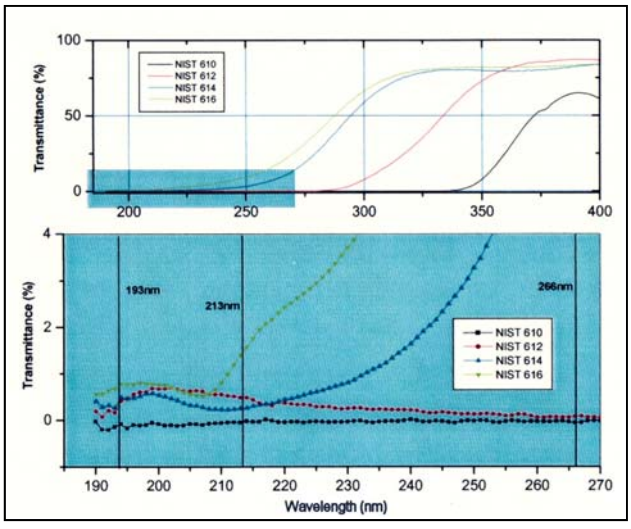


Figure 1: Light transmission through NIST 61X SRM glass
Transmission of light through a glass matrix approaches zero (high absorbance) as the wavelength of light approaches 193nm (deep UV). NIST 610 (high standard) is a dark translucent blue. NIST 616 (low standard) is clear and visually transparent.

Laser irradiance (fluence/pulse width), measured in Watts/cm^2, is a critical component of the laser-material interaction.[6,7] Localized heating of the sample lattice increases with longer pulse widths. The design of a solid state 193nm laser with a very short pulse width < 3ns offers the advantage of both deep UV ablation and reduced thermal effects.

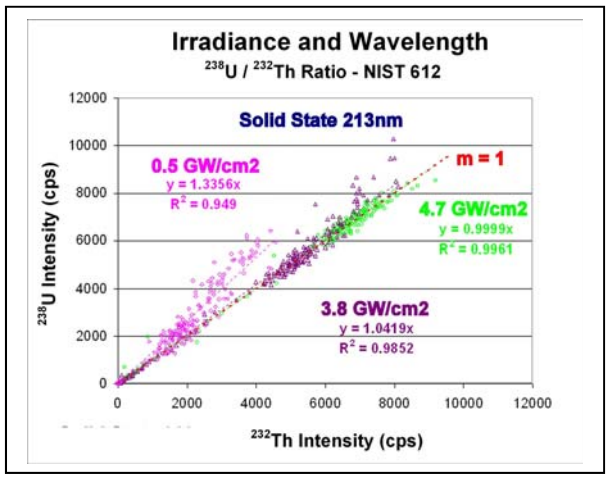


Figure 2: Irradiance and particle size effect on U/Th ratio (213nm)
With proper irradiance the longer 213nm wavelength is very effective in eliminating particle size induced fractionation.

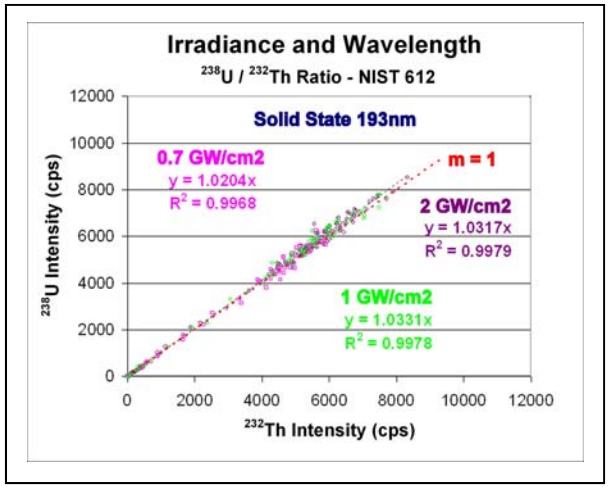


Figure 3: Irradiance and particle size effect on U/Th ratio (193nm)
A consistent U/Th ratio over a range of laser fluence benefits from the deep UV 193nm, short pulse width (sub 3 ns) of the UP-193 Solid State system.

NEW WAVE™ RESEARCH

The enhanced absorbance characteristics of the 193nm wavelength ensure good coupling of laser energy at the surface of the sample, reducing the depth penetration rate and mean particle size which has been identified as contributing to elemental fractionation.

The differences in the $^{238}U/^{232}Th$ ratio has been used as a qualitative measure of particle size.[8] This ratio is effected by the efficiency with which an inductively coupled plasma can digest and ionize the elemental components of solid particles, then present a stoichiometrically accurate signal to the detector of a mass spectrometer.

Irradiance

As can been seen from Fig. 2, the 213nm wavelength can accurately determine the correct $^{238}U/^{232}Th$ ratio if operating at the proper irradiance. However below its ablation threshold (low irradiance), the ratio falls off. The solid state 193nm wavelength appears to be less effected by irradiance in these materials (Fig. 3).

Sample Matrix

Accurate U/Th ratios for UV opaque (610) and UV transmissive (614) samples can be acquired with little difficulty at 193nm (Fig. 4). The values are steady over the entire 60 second, 600 shot, ablation period (Fig. 5).

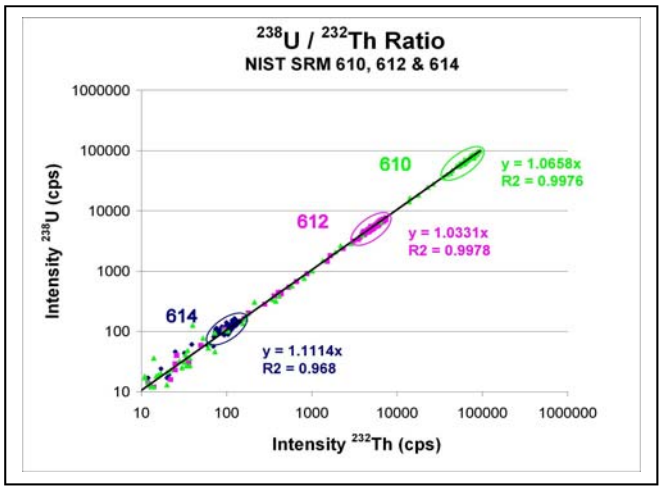


Figure 4: U/Th ratio in NIST 61X series glass
The U/Th elemental ratio is nominally 1 for SRM 610 and 612 [Pierce et al '97] and 1.1 for 614 [Gao et al '02]. The ability to accurately determine elemental ratios in samples with differing physical properties suggests an improved matrix insensitivity.

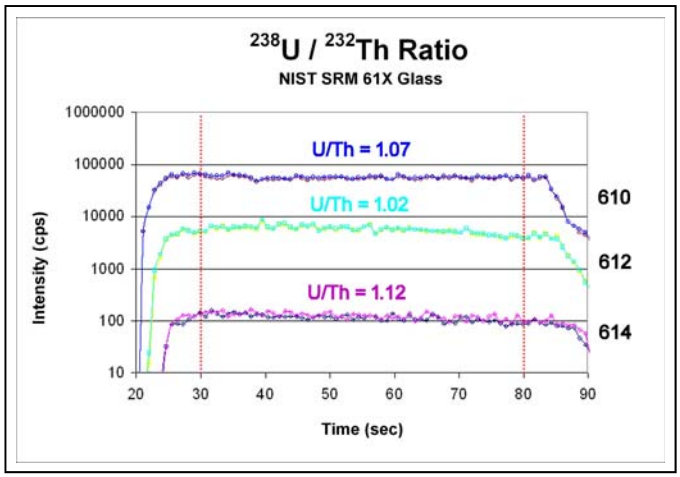


Figure 5: Accurate U/Th ratios - NIST 61X glasses
Time trace of single spot ablation in NIST glass. As in figure 4, The UP-193 solid state laser displays consistent results even in transparent glass. Published ratios for ^{238}U / ^{232}Th in SRM: 610 (1.0), 612 (1.0), 614 (1.1).[9,10] Dotted lines signify integration area boundary.

Conclusion

In laser ablation solid sampling there is an interplay between laser wavelength, laser irradiance and sample matrix. Ultimately one wants to obtain the same level of analytical precision and accuracy, for all elements in a solid, regardless of sample type. The UP-193 Solid State laser system displays enhanced ablation characteristics. Depth penetration rate, aerosol particle size and matrix independence all appear to be enhanced. This suggests that operating at 193nm wavelength with a very short pulse width offers a more matrix independent option when doing direct solid sampling analysis.

References

1. Neufeld, L. and Roy, J. , Spectroscopy (2004) 19[1], 16.
2. Geersten, C., Briand, A., Chartier, F., Lacour, J.L., Mauchien, P., Sjostrom, S. and Mermet, J.M., J. Anal. Atom. Spectrom. (1994) 9, 17.
3. Jeffries, T.E., Perkins,W.T. and Pearce, N.J.G., Analyst (1995) 120, 1365.
4. Gunther, D., Frischknecht, R., Heinrich, C.A. and Kahlert, H.J., J. Anal. Atom. Spectrom. (1997) 12, 939
5. Jeffries, T.E., Jackson, S.E., and Longerich, H.P., J. Anal. Atom. Spectrometry (1998) 13, 935.
6. Russo R.E., Mao X.L, O.V.Borisov, and Liu H., Encyclopedia of Analytical Chemistry: Instrumentation and Applications (2000).
7. Russo, R.E., Mao, X.L. and Mao, S.S., Anal. Chem. (2002), 74 [3], 70A-77A.
8. Guillong, M., Gunther, D, J. Anal. At. Spectrom., (2002), 17, 831 - 837
9. Pierce, N.J.G. et al, Geostandards News. (1997) 21[1], 115.
10. Gao, S. et al, Geostandards News. (2002) 26[2], 181.

Warranty

One year warranty, details provided upon request.

NEW WAVE RESEARCH

www.new-wave.com

CLASS 1 LASER PRODUCT

USA
New Wave™ Research, Inc.
48660 Kato Road
Fremont, CA. 94538-7339
Tel: 510-249-1550
Tel: 800-566-1743
Fax: 510-249-1551
Email: Lasers@new-wave.com

Japan
New Wave™ Research, KK
5F Chojiya Building, 1-36-4,
Shinjuku-ku, Shinjuku
Tokyo, 160-0022 Japan
Tel: +81-3-3351-0131
Fax: +81-3-3351-0121
Email: NewWaveKK@new-wave.com

Taiwan
New Wave™ Research G. C. Co., Ltd.
No. 58-3, XingShan Rd.,
Neihu Dist.,
Taipei 114 Taiwan
Tel: 886-2-8792-7585
Fax: 886-2-8792-7584
Email: NewWaveGC@new-wave.com

Europe
New Wave™ Research Co., Ltd.
8 Avro Court Ermine Business Park
Huntingdon, Cambs
England, PE29 6XS, UK
Tel: 44-(0)1480 456566
Fax: 44-(0)1480 456545
Email: NewWaveEU@new-wave.com

China
New Wave™ Research (China) Co., Ltd.
Rm. 1102, 11/F, Jiaxing Mansion,
No. 877, Dongfang Rd.
Shanghai 200122, China
Tel: 86-21-5058-7785
Fax: 86-21-5058-7786
Email: NewWaveCN@new-wave.com