The Helium Effect

Benefit of alternate cell gas for laser ablation analysis

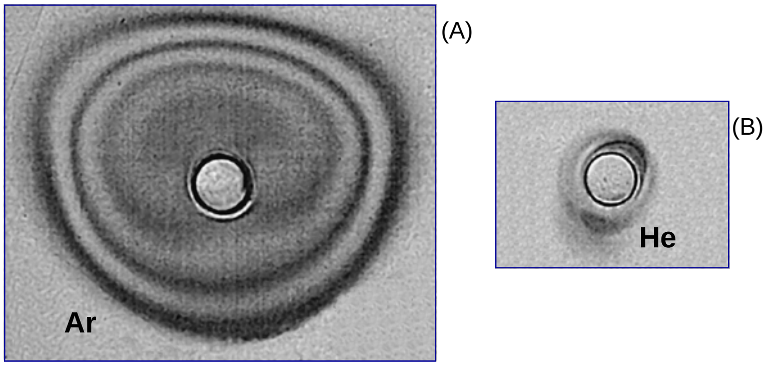

Figure 1: Condensation deposits Ar vs. He atmosphere
Ablation in Argon **(A)** and Helium **(B)**. 60 laser pulses display clear differences in the degree of condensation blanket deposited back onto sample surface.
Courtesy of S.M. Eggins (Ref 2)

Why Helium?

There is growing evidence to suggest that the presence of helium gas in the ablation cell displays a beneficial effect on particle size distribution, aerosol transport, reduced elemental fractionation and plasma shielding, relative to argon.[1,2,3] It has been observed that the laser ablation blanket is reduced in the presence of helium **(Fig. 1)**.[2,5]

We feel there is an overall and general benefit to implementing helium as the cell gas for a wide variety of laser ablation applications. There are a number of mechanisms that may explain the analytical benefits of helium as an ablation/carrier gas.

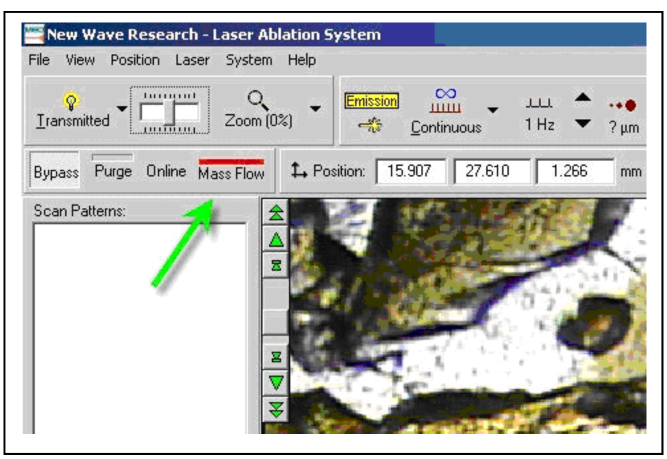

Figure 2: Universal Platform software screen
Extracted image of optional mass flow control activation button.

The stability of the carrier gas that transports the laser aerosol to the ICP significantly effects analytical precision. An integrated, mass flow control option offered by New Wave Research (Figure 2, 5a,b) insures accurate and precise control of alternate sample gases such as helium.

Benefit of Helium in the ablation cell

- **Thermal Conductivity:**
  It has been suggested that the rapid removal of thermal energy from the laser induced plasma in a helium environment inhibits the condensation of smaller particles into larger ones .[3] These larger particles are more difficult for the ICP to "digest", leading to increased elemental fractionation.[4]
- **Plasma Expansion:**
  Suggested models of the expanding laser plasma in ambient gas describe a high pressure leading edge that is stalled by the dense argon gas, causing condensed particles to deposit back on the sample surface. Helium, having a density 10x less than argon, minimizes this effect.[5]
- **Plasma Shielding:**
  The laser induced plasma, common to laser ablation, is composed of sample atoms and ions, electrons and the carrier gas species.[1] There is an observed correlation between reduced plasma shielding, in a helium environment, and an increase in mass ablation rate. This is likely due, in part, to the high ionization potential of helium relative to argon **(Fig. 3)**.

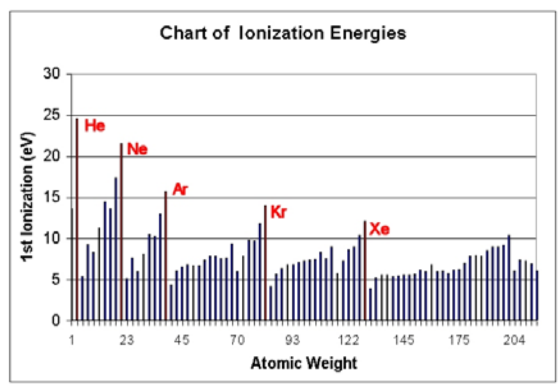

Figure 3: Noble gas ionization energies
Transport gases with high 1st ionization energies (He, Ne) display increased laser ablation sampling efficiency compared to gases with lower 1st ionization energies (Ar, Kr, Xe)

1. Russo, R.E., *Appl. Spectrosc.*, (1995), **49**, 9, 14A
2. Eggins, S.M., et al, *Appl. Surf. Sci., (*1998), **127-129**, 299
3. Horn, I., et al, *Appl. Surf. Sci., (*2002), **9710**, 1
4. Figg,D.J., et al, *Appl. Surf. Sci*., (1998), **129**, 287
5. Mank, A.J.G., et al, *JAAS*, (1999), **14**, 1143

NEW WAVE™ RESEARCH

Connectivity

The figures at right **(4 & 5)** display the suggested method of connecting and controlling your Universal Platform laser ablation system to the mass spectrometer. It is strongly suggested that 99.999% pure helium and argon gas be used as the cell and makeup gases, respectively. The supplies should be flow controlled to insure the best analytical stability. New Wave Research has therefore developed a fully integrated mass flow control option. For further information please contact your local representative.

Configuration: **(see Figure 4)**

- Connect the regulated helium supply to the Universal Platform (UP) gas INPUT Swage™ connector
- Using a short (2” to 4”) piece of Tygon™ tubing, connect the UP OUTPUT Swage™ to the 4mm OD Y-connector (Cole Parmer EW-06295-10)
- Connect the argon supply (from MS) to the second leg of the Y-connector
- Connect a length of Tygon™ tubing from the third, straight leg of the Y-connector to the ICP torch, using the appropriate torch adapter
- Secure all the fittings with a tube clamp (Cole Parmer EW-06832-01)

Suggested Gas Flows:

Helium cell gas: 0.25L/min to 0.50L/min
Argon make-up gas: 0.40L/min to 0.80L/min

Conclusion

Using helium as a cell gas enhances laser ablation and aerosol transport dynamics. Though short UV wavelengths (213nm, 193nm) seem to benefit more from an ambient helium environment; longer 266nm ablation **(Fig. 6b, 6c)** also benefits from the use of helium.

Configuring your Universal Platform laser ablation system to accept a helium supply is easy and straight forward. It is fully compatible with our automated functionality and enhances the overall system performance.

- Greatest benefit at shorter wavelengths (193nm, 213nm)
- 2-3 times increase in signal intensity
- Increased percentage of small particles
- Reduces elemental fractionation
- Minimizes condensation blanket

Universal Platform - Output Connections

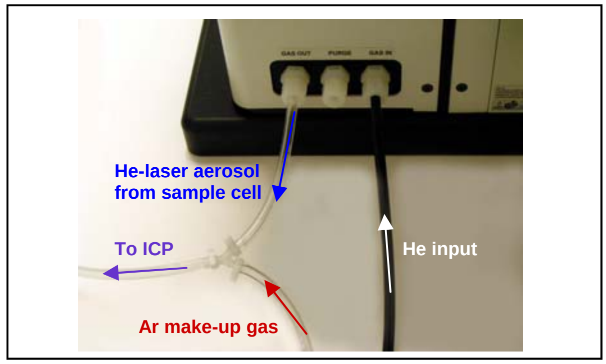

Figure 4

Universal Platform - Mass Flow Control Option

Figure 5a: Cutout showing MFC

The unique design of the Universal Platform has enabled the smooth integration of a MFC option into our laser ablation systems (5a,b).

Figure 5b: Flow Control Screen

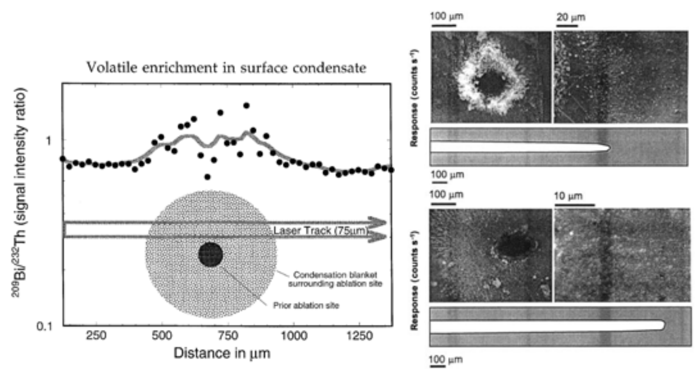

Figure 6: Helium Effect
The condensation blanket formed on NIST glass, in an argon environment, is enriched in the more volatile Bi, **(a)**. Reduced deposition of condensate and increased mass ablation rate are two benefits of using helium **(c)** vs. argon **(b)** in the ablation cell.

Fig. 6a was extracted from Eggins, et al (1998). **Fig. 6b** and **6c** were extracted from Mank, et al (1999).

Ordering Information

Mass Flow Controller: PN 0020-1591

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