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Laser Ablation Molecular Isotopic Spectroscopy (LAMIS)

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Laser ablation is an excellent technology for rapidly measuring the chemistry (elemental and isotope content) of a sample [1]. The laser pulse duration and energy drives the process of ablation, which converts a portion of a sample into a luminous optical plasmas that condenses to a fine aerosol. Chemical analysis is instantaneous by measuring the emission spectra in the optical plasma, or by transporting the aerosol to a secondary source for excitation and analysis. The physics of the laser matter interaction influences chemical analysis capabilities, including range of elements detected, sensitivity of converting laser photons to ablated mass, and accuracy and precision of analysis. Traditionally, laser ablation sampling has been coupled with ICP-MS (Inductively Coupled Plasma Mass Spectrometry) for sensitive isotopic analysis. Alternatively, optical emission from the luminous plasma initiated by the ablation process at the sample surface can be monitored and provide elemental analysis and in some cases isotopic analysis. This well-known optical approach is called LIBS (Laser-Induced Breakdown Spectroscopy). Overall, LIBS is not ideally suited for isotopic analysis due to poorly resolved spectral shifts in atomic and ionic spectra from isotopes, especially in atmospheric pressure laser plasmas. However, our new technology LAMIS (Laser Ablation Molecular Isotopic Spectroscopy) shows the ability to perform isotope measurements in these laser plasmas at atmospheric pressure [2-3]. By expanding the capabilities of classical LIBS to emphasize the measurement of molecular emission spectra in addition to elemental, LAMIS provides the ability to measure all elements and their isotopes, especially light elements like Li, Be, C, N, O which are impossible with XRF. Molecular isotopic shifts are orders of magnitude greater than atomic and ionic transitions. By measuring molecular emission spectra as the plasma cools, isotopic spectral splitting is enhanced up to several orders of magnitude. We developed LAMIS to date by demonstrating its ability to measure B, C, H, D, Sr and other isotopes. We demonstrated low percent levels for sensitivity and have experimental plans to meet ppm levels. For some isotopes, we have achieved <0.1% precision. The talk will describe the isotope work that has been reported in LIBS plasmas and show how LAMIS expands those capabilities.

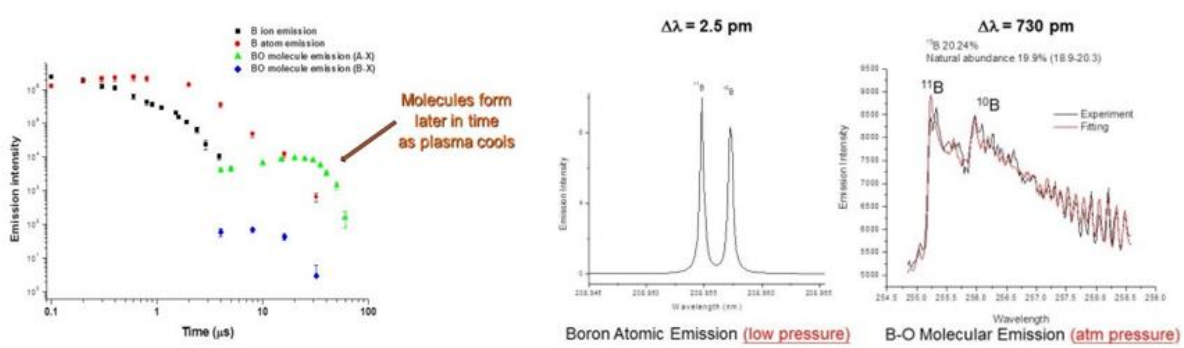

Figure 1: Temporal emission of the laser plasma. Atomic versus molecular isotope emission spectra

References:

[1] Russo R, et al. (2013) Analytical Chemistry 85: 6162

[2] Mao XL, et al. (2011) Spectrochimica Acta B66: 767-775

[3] Russo RE, et al. (2011) Spectrochimica Acta B66: 99-104