Optimization of LIBS parameters for polymer evaluation

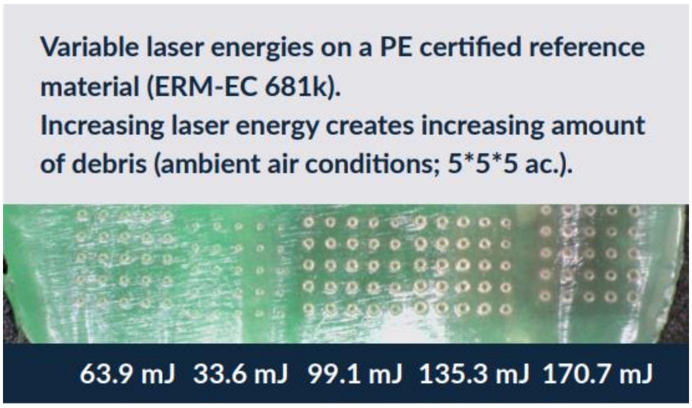
Challenges

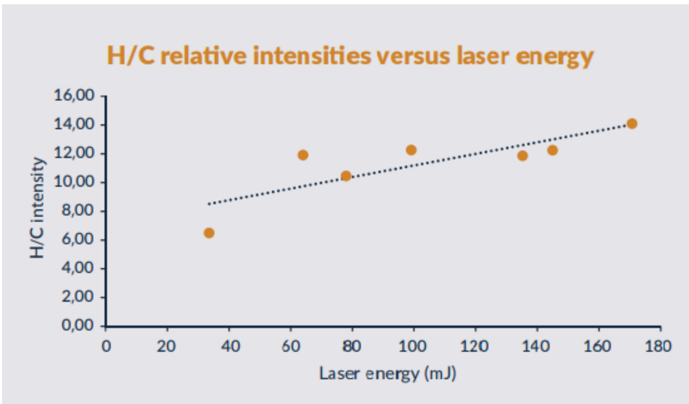
Ensuring accurate and consistent polymer evaluation using **LIBS** requires the optimization of multiple parameters. Key factors such as **laser energy, defocus height, gate delay, integration time,** and **argon wash** conditions must be carefully adjusted to achieve reliable results. Since different polymers respond differently to laser ablation, finding the right combination of settings is essential for precise material characterization.

Solution

Optimizing key **LIBS** parameters is essential for achieving accurate and reliable polymer evaluation. Carefully adjusting **laser energy** ensures a strong and stable signal while preventing material damage. Fine-tuning the **defocus height** enhances plasma formation, improving both signal strength and spectral clarity. Setting the optimal **gate delay** allows emission signals to be captured at peak intensity for precise elemental analysis. Similarly, optimizing **integration time** helps balance signal capture and noise reduction, ensuring consistent measurements. Finally, controlling **argon wash** conditions minimizes background interference, resulting in cleaner spectra and enhanced detection sensitivity.

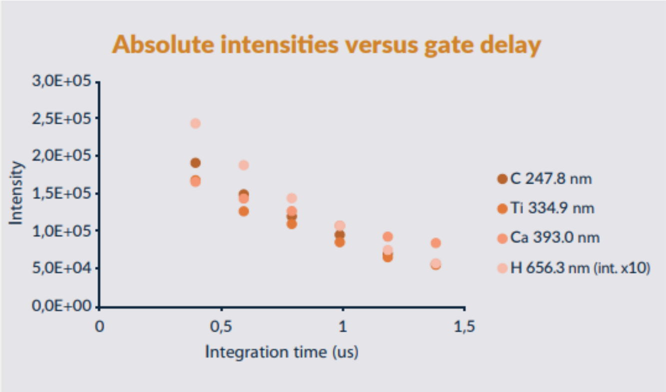
Results

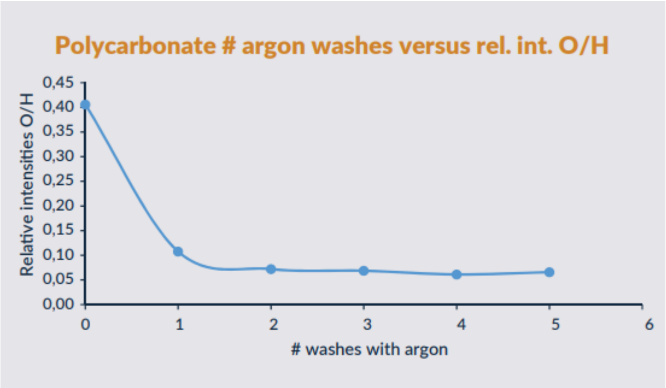




Higher laser energies improve signal intensity but also increase contamination and damage, therefore optimizing energy levels is essential to maintain a balance between signal strength and sample integrity. Using a controlled atmosphere, like argon, may help reduce the debris effect.

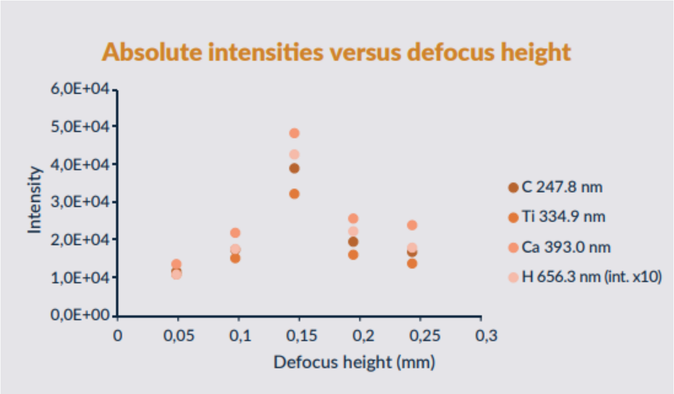
Optimizing the integration time is important to achieve the best signal-to-noise ratio and ensure precise, reliable measurements. With changes in the integration time, the intensities of elements vary individually. From the graph, it is evident that as the integration time increases, the intensities decrease for each element.





With increasing number of argon washes, the relative intensities of O/H species decrease, minimizing spectral interference from atmospheric contaminants and enhancing the precision and reliability of LIBS analysis.

Optimizing the defocus or the depth of focus of the laser beam, is crucial to maximize signal strength while minimizing potential distortion or loss of resolution in the spectra. The trend is the same for all elements, with the highest intensity achieved at a defocus of 0.15 mm for this specific case.



LIBS Principles

Laser Induced Breakdown Spectroscopy (LIBS) is an optical emission tool for the quick characterization of chemical elements in a broad range of materials, including biological, geological, and ceramic materials. A highly energetic laser pulse is directed at the target sample (Figure 1), resulting in the creation of an expanding microplasma upon impact. This microplasma emits luminous species that provide valuable information about the material composition and the sample environment.

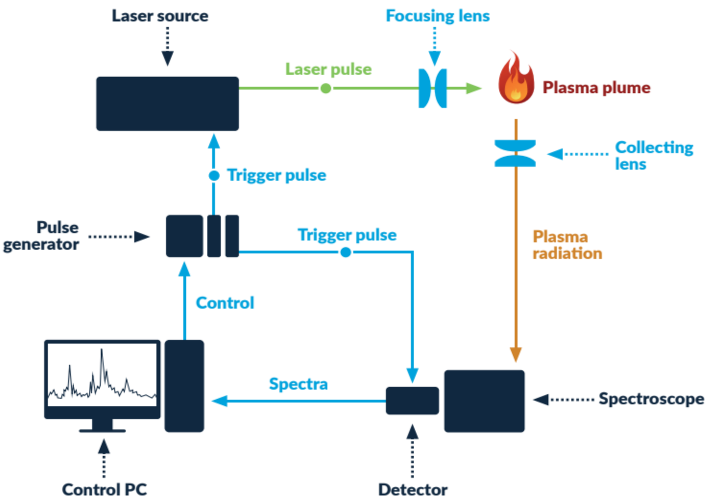


Figure 1: Sci-Trace LIBS set-up scheme