Characterization of plastic materials using LIBS

Challenges

Characterizing plastic materials using **LIBS** presents several challenges due to their complex composition and low intrinsic conductivity. Plastics often contain a wide range of additives, fillers, and pigments, which can interfere with spectral signals and make accurate elemental analysis difficult. Additionally, the high hydrogen and carbon content of plastics can lead to strong background emissions, reducing detection sensitivity. Another challenge is the low ablation efficiency of polymers, which can result in weak signal intensities and less reliable quantitative measurements.

Solution

A significant improvement in **LIBS-based** plastic characterization can be achieved by conducting measurements in an argon atmosphere. The use of argon as a buffer gas reduces background emissions and enhances signal intensity, leading to more precise and reliable elemental detection. As shown in Figure 1, compared to ambient air conditions, laser ablation in an argon atmosphere generates more pyrolytic debris, which can improve signal strength and enhance measurement accuracy. In an inert environment, matrix effects are minimized, allowing for better differentiation of key elements and improved repeatability of results.

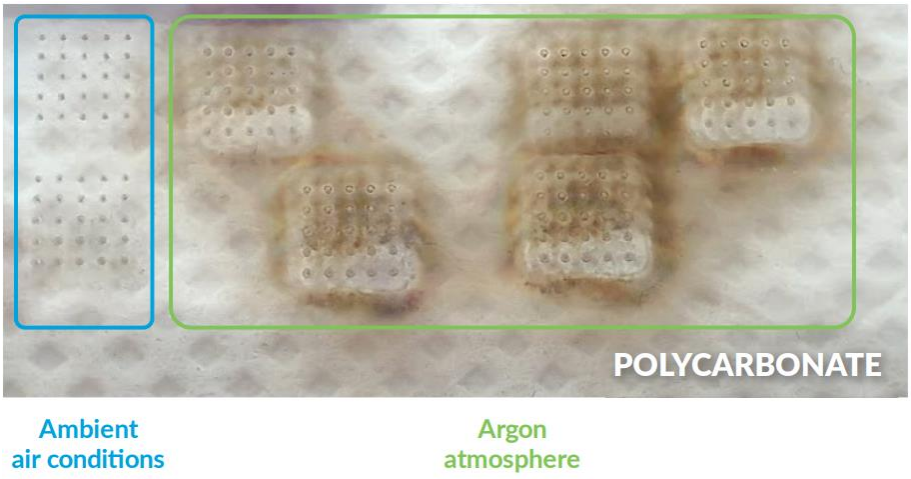

Figure 1: Laser ablated polycarbonate material after measurements in ambient air and under argon atmosphere.

Results

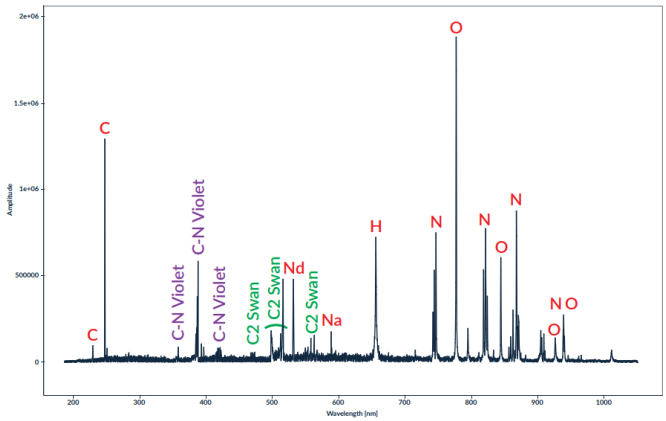

Figure 2: LIBS spectrum from a transparent PET sample measured in ambient air.

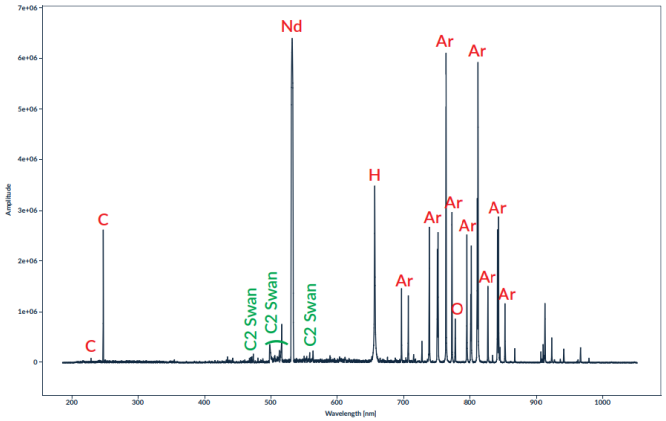

Figure 3: LIBS spectrum from a transparent PET sample measured in argon atmosphere.

Sample	Atomic composition	# argon washes	Rel. areas O/C	Rel. areas O/H	Rel. areas H/C
PET – transparent	$C_{10}H_{10}O_4$	3	1.28	0.13	9.7
PP – transparent	C_3H_6	3	0.24	0.02	13.6
PS – transparent	C_8H_8	3	0.22	0.02	10.0
PC – transparent PC – transparent	$C_{16}H_{18}O_3$ $C_{16}H_{18}O_3$	3 5	0.57 0.54	0.07 0.07	8.3 8.2
HDPE – white Ca/Ti filled	C_2H_4 $CaCO_3 + TiO_2$	3	0.54	0.03	16.3

As can be seen in the spectra, measurements conducted in an argon atmosphere significantly improve the results. The reduced background interference, enhanced signal intensity, and increased pyrolytic debris contribute to clearer and more precise elemental detection. This leads to better sensitivity, improved repeatability, and overall more reliable characterization of plastic materials using **LIBS**.

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 4), 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.

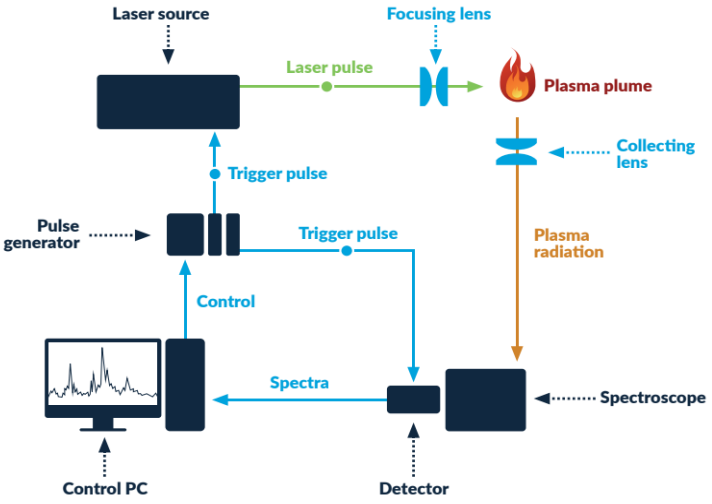

Figure 4: Sci-Trace LIBS set-up scheme

