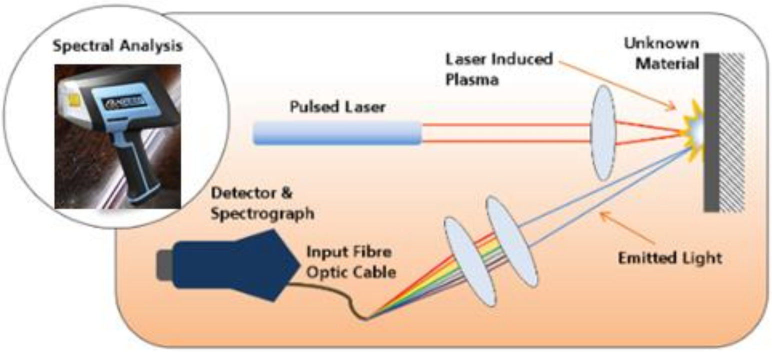
CALIBUS

Principles of LIBS

PRINCIPLES OF LIBS

Laser Induced Breakdown Spectroscopy (LIBS) is a type of optical emission spectroscopy used to measure elemental concentrations in a material. In LIBS, a laser pulse strikes the surface of the sample and ablates an amount of material in the range of 1 ng and generates a plasma plume (partially ionized gas) in the temperature range of 4,700-19,700°C. The energy of the laser is low but is focused to a microscopic point on the sample to generate the plasma. In this plasma, the matter constituting the samples is dissociated into atoms (atomization) and partially ionized. Those atoms and ions will be excited (transition of electrons from lower to higher energy levels of valence shell) and by returning into their ground state (transition from higher to lower level of valence shell) they will emit characteristic lines for each element.



The emitted light is transmitted through optical fibres and the polychromatic radiation is dispersed in one or more spectrometers by diffraction gratings and detected by CCD (or CMOS) chips. The spectra of LIBS can contain hundreds or even thousands of lines for a single element. The sensitivity of those lines can differ by several orders of magnitude and result in extremely line rich spectra, especially when the sample contains high concentrations of transition metals as it is the case for alloys like stainless steel. In typical LIBS systems, the dispersion power of the spectrometer is often limited by its size and some important analytical lines may not be fully resolved from lines emitted by the matrix.

To cover the entire spectral range between 180 and 800 nm, multiple spectrometers may be required. Moreover, wavelengths of less than 200 nm (like C 193.09 nm or S 180.73 nm) are strongly absorbed by air and require an argon purge of the optical path to be detected. Almost any element generally contained in metals can be detected with LIBS:

the sensitivity for alkaline (Li, Na, etc.) and alkaline-earth metals (Be, Mg, etc.) is very high and the sensitivity for transition metals is good, except for refractory elements like Nb, Mo, W, or Ta which are difficult to determine. The sensitivity for P and S is generally not sufficient to analyse those elements at relevant levels in alloys. Carbon can be detected in carbon steel and cast iron.