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Emission spectrometry on a laser-produced plasma for isotopic analytical control

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Laser-produced plasmas as photon source for emission spectrometry are studied by several groups [1,2] for the aim of direct elemental analytical control. This type of plasma coupled with optical emission spectroscopy (OES/LPP) provides several advantages. All types of samples to be analyzed (metals (solid or molten), ceramics, glass, compounds, ...) can be used without chemical preparation. You can carry out a global mass analysis or a localized control with the possibility of cartography. Also a on-line analysis can be applied.

In this work we study the possibility using OES/LPP at reduced pressure for the determination of the isotopic ratio on elements with high atomic number. This application requires sufficient small emission line widths. For this purpose we analyze experimental conditions for the spatio-temporal plasma expansion which provide a high spatial and spectral resolution. We investigate different relevant plasma parameters responsible for the measured line widths of the observed transition (e.g. laser power, time behaviour of energy level population, expansion velocity of the particles above the target surface and the spatial distribution of these parameters in the plasma plume).

First experiments are performed in order to study spectral lines in a pure copper matrix. A plasma expansion model is developed by pictures taken with an intensified and gated CCD camera during the first microsecond of the plasma evolution. A gate width of 15 ns is short enough for stop-action pictures. With the help of this plasma cartography (three dimensional: x ($= y$), z and t) the results obtained by optical emission spectroscopy (line widths and intensities) are related to the spatial position of the plasma fraction investigated in the plasma plume at a certain time delay t of the boxcar gate. The relation established between the full line width and the investigated plasma fraction helps to interpret the contribution of different plasma parameters [3,4]. A best value of 0.1 Å for the line width (FWHM) of the copper transition 5105 Å is obtained at 0.6 mm height.

The line width of 0.1 Å shows the interest to apply this method on elements with high atomic number. We present experimental results showing a precision better than 3% for the determination of the isotopic ratio. Advantages and possibilities of this new type of isotopic analytical control are discussed.

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