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A New Method for Measuring Chemical Composition with Hollow Cathode Discharges

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In this study a new spectroscopic approach for analysis of chemical composition using hollow cathode discharges is introduced. The influence of the physical dimensions as well as the ratio aspect (length/diameter) of the discharges on the measurements was investigated. Several spectral lines of some elements have been observed, especially those originated from decaying transitions to the ground state and metastable states. Our approach consist in select spectral lines, whose light intensity can be represent in terms of the invariant parameter associated with the discharge current density and pressure. Whenever a quantity can be represented in terms of an invariant parameter, it can be scaled up for other discharges with the same cathode material and filling gas, but with different dimensions and operated under different conditions. A correlation between the light intensities of spectral lines of some selected elements and their relative chemical composition on different samples was found by plotting these quantities as a function of the invariant parameter. The measurements were made for several commercial samples containing Fe, Cr, Ni, Ti and Al. A better overlapping of the experimental points occurs in the low current range, where the gas temperature is close to the room temperature and the density of sputtered metal atoms is low compared to the density of the gas atoms. In this case, the discharge is manly sustained by the ionization collisions of the beam electrons emitted by the cathode with the argon atoms. So far the sputtered metal atoms do not play a significant role on the discharge self-sustaining mechanism, deviations from the characteristic curves are small.

Keywords
Hollow cathode
chemical composition
emission spectroscopy
invariant parameter