

Bulk characterization of “Estado Novo” coins by Laser Induced Breakdown Spectroscopy

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The present work studies the optical emission spectroscopy of the plasma generated by a pulsed 4ns, 25mJ Nd:YAG laser beam irradiating a 1000 "Reis" aluminum bronze coin forged in 1939 with the effigy of Tobias Barreto, an illustrious Brazilian. A signal optimization was performed for the acquisition of the spectra and the time delay between the laser pulse and the start of the spectroscopic signal integration was 1 μ s and integration time gate was 2 μ s. Characteristically, the laser interaction allows a layer by layer analysis and the third laser shot (used in this characterization) corresponds to a 120 μ m depth (as determined by 3D reconstructed image using OCT technique). The average plasma temperature was 9500 (400) K and agreed with the excitation temperature evaluated for atomic lines. Additionally, the electronic density was determined by two techniques and the value was $4 \cdot 10^{16} \text{cm}^{-3}$ using Saha - Boltzmann method for copper lines and $9.9 \cdot 10^{17} \text{cm}^{-3}$ using Stark Broadening method for aluminum. The elemental composition of coin bulk was calculated using CF-LIBS technique applied to the experimental data. Comparing the edict-law composition to the major elements (Cu, Al, Zn) gives a good agreement using ANOVA test. Besides, some impurities were found in the bulk material, for instance Ca and Fe.