Determination of temperature from air sparks induced by high intensity laser - comparison between experimental data and theoretical models

Marcello M. Amaral, Luiz V.G. Tarelho, Lilia C. Courrol, Anderson Z. de Freitas, Ricardo E.Samad, Laércio Gomes, Nilson D. Vieira Junior
CLA - IPEN - SP - Brasil

Laser induced spark in air is a very interesting physical phenomena, specially for high intensity lasers. In this work, some experimental data of plasma emission from air was compared to theoretical data based on Saha and Boltzmann distribution from NIST database. Two models for temperature determination: two-line method and atomic Boltzmann plot were carried through for both experimental and theoretical data. In order to evaluate the high temperature plasmas generated by this laser an spectroscopic method can be useful but there are no temperature standards higher than 4,000K. Experimental spectra from atomic lines of Nitrogen, Oxygen and Argon were measured in two situations: after 7ns and 500μs from the laser pulse. Theoretical data were collected from NIST database for the same transitions observed experimentally. The limitations and validity for each method employed were evaluated. For a delay time of 500μs the temperature obtained with two-line radiance method for Saha distribution was 3.77eV and for Boltzmann distribution was 11.54eV, this second in good agreement with the experimental temperature obtained with atomic Boltzmann plot equal to 11.22eV(130,000K). The accuracy of Boltzmann plot to Saha distribution is strongly affected for temperatures greater than 3eV, that is due to the change on ionic fraction distribution in Saha theory. For 7ns delay time the temperature was 20eV (230,000K). Local thermodynamic equilibrium can be assumed for laser induced plasma in every moment and the temperature can be defined for experimental data, confirming Boltzmann distribution as the best description but the ionic fraction equilibrium is not achieved and the Saha distribution does not describe the physical picture.
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