Collisional Radiative Model for Zn laser produced plasma

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Smijesh et al. [1] have recently reported time and space resolved spectral measurements of neutral Zn emission from an ultrafast laser produced plasma, generated by the irradiation of a Zn target with laser pulses of 100 femtoseconds duration, carried out in a broad ambient pressure range of 0.05 to 100 Torr. They have obtained the plasma parameters viz. electron temperature (T_e) and electron density (n_e) from their measured optical emission spectra using simple local thermodynamic equilibrium (LTE) model. Thus, it would be interesting and worth developing a detailed collisional radiative (CR) model to obtain the reliable plasma parameters from the spectral analysis of laser produced Zn plasma (LPZP).

In the present work, we develop a detailed CR model in the light of the LPZP emission measurements of Smijesh et al. [1]. In such plasma, the electron impact excitation of Zn is a dominant process and for the modeling purposes the excitation cross sections for the various fine structure transitions involved among ground state and excited states. However, very few studies reported the electron impact excitation cross sections of Zn. Mostly these are available for the transition from the ground state ($4s^2$) to the 4s4p excited state [2]. Consequently, we first find out, the electron excitation cross sections of neutral zinc using fully relativistic distorted wave (RDW) theory [2] for several transitions involving the ground and excited states. Further, calculated cross sections are incorporated in the CR model and evaluate the plasma parameters.

In the present, CR model 30 fine structure levels have been included along with the ground state of Zn and Zn^+ which are interconnected through collisional and radiative transitions occurring in the plasma. The model incorporates various population transfer kinetic processes among fine structure levels such as electron impact excitation, ionization and radiative decay along with their reverse processes e.g. electron impact de-excitation and three body recombination [3]. The plasma parameters viz. electron density (n_e) and electron temperature (T_e) are evaluated for the pressure range 0.05-10 Torr and at 2.0 mm distance from the target surface. The details of the excitation cross sections results along with the CR model results will be presented in the conference.

References

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