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Diagnostics of Kr^+ plasma using collisional radiative model with detailed electron impact fine-structure excitation cross-section calculations

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Low-pressure plasmas are having important applications such as in materials processing, in particular for deposition and etching of thin films for electronic, optoelectronic and photonic devices [1]. Recently, plasma of Kr and it's ions have been explored and considered for such selected applications. In the present work, we consider the diagnostics of low-temperature Kr^+ plasma using collisional radiative model (CR). We need extensive electron excitation cross-section data of the fine structure levels of Kr^+ which are dominant process at low temperature. These cross-sections will be incorporated in the collisional radiative model. We applied the model to the optical emission spectroscopy measurements of Kr^+, reported by Mar et al.[2].

We have calculated electron impact excitation cross-sections of several levels of Kr^+ using the fully relativistic distorted wave theory [3]. We determined the required wave functions of Kr^+ in the multi-configuration Dirac-Fock approximation and validated them by comparing the calculated energy levels and some transition probabilities with previously reported values. In the CR model, some selected important excitation transitions from the ground, quasi-metastable and metastable states of Kr^+ have been considered along with other plasma processes. We utilized the measured intensities of five emission lines of Kr^+ [2] and compared these with the values obtained from the CR model to extract plasma parameters, specifically, the electron temperature, electron density and other plasma parameters.

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