Collision Radiative Models for the Diagnostics of Rare Gas (Ar, Ne) Plasmas with Trace Admixture of Molecular Gases ($O_2/H_2/N_2/CO_2$).

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Molecular gases are admixed in trace amount to the rare gas plasmas to improve their characteristics and make them suitable for various applications. Ar-N_2 plasma finds application in nitriding the stainless steel [1]. Ar-O_2 discharge are used in the plasma enhanced-chemical vapor deposition, protein etching, surface modification, sterilizing the bacteria etc.[2]. Conversion of CO_2 for environmental remedies is also done using different type of rare gas plasma [3]. Most of the above application utilizes argon plasma with molecular mixture, however neon can be a efficient substitute of argon in some of the applications [4]. Considering these applications, the detailed diagnostic of these plasmas is required to reveal and improve their characteristic features to utilize them in different applications. As the probe measurements lead to disturb the plasma, the optical absorption and emission spectroscopic (OAS and OES) measurements based non-invasive techniques become very useful for diagnostic of such plasmas [5]. In these techniques, suitable collisional radiative models are coupled with OAS/OES measurements to extract the various plasma parameters e.g., electron temperature, electron density etc. In our work, we have developed suitable collisional radiative models for diagnostic of different pure Ar, Ne and mixture Ar-N_2, Ar-O_2, Ar-CO_2, Ne-Ar, Ne-O_2 and Ne-H_2 plasmas [6-7]. In these CR models, we have incorporated various collisional and radiative processes occurring in the plasma viz. electron impact excitation and de-excitation, radiative decay, self-absorption correction, ionization, two and three body recombination etc. In low temperature plasmas, electron impact collision processes are dominant and their proper inclusion in the CR model requires an accurate and consistent dataset of cross-section corresponding to the different elastic and non-elastic processes [8]. Measurement of cross-sections for such large number of transitions are not possible and most of the other CR models have used cross-sections from different sources which are inconsistent and directly affect the accuracy of plasma parameters extracted through CR models. We have calculated the required fine structure resolved electron impact cross-sections of several transitions using fully relativistic distorted wave (RDW) method which is a very reliable and efficient method of obtaining cross-sections [8]. The developed CR models are coupled with different OES or OAS measurements through matching of either the line emission intensities or populations of species in the plasma to extract the various plasma parameters e.g., electron temperature, electron density, line emission intensities and metastable and resonance level populations, electron impact rates etc. Wherever possible, our extracted plasma parameters obtained from the CR models are compared with the available probe measured [10] and other results. The details of our CR models along with all the calculations and results will be presented and discussed in the conference.

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