

Quantitative Diagnostics of Inductively-coupled Radiofrequency Plasmas in Cl₂, O₂ and mixtures

Jean-Paul Booth,^{1*} Mick  el Foucher, Andrew Gibson and Daniil Marinov

¹ LPP-CNRS, Ecole Polytechnique-UPMC-UPsud, 91128 Palaiseau, France

* Corresponding author: jean-paul.booth@lpp.polytechnique.fr

Inductively-coupled plasmas in molecular, electronegative gases are widely used for plasma processing of surfaces, for instance in CMOS manufacture. The complexity of these systems is such that they can only be described by multi-physics models which describe both the plasma physics and the molecular collisional processes. However, there has been little rigorous validation of these models by comparison to quantitative measurements of particle densities over a wide range of parameter space. We have chosen to study the Cl₂/O₂ system partly because of the industrial process relevance but also because methods exist to measure the density, and energy distributions, of most of the particles present. Electron densities were measured by microwave hairpin resonator. Absolute Cl and O atom densities were determined by Two-photon Absorption Laser-Induced Fluorescence [1, 2]. We have constructed a new ultra-low noise broadband UV-visible absorption bench[3], which allows the measurement of the densities of ground state Cl₂ molecules and Cl_xO_y reaction products, as well as vibrationally excited states of O₂ [3] and Cl₂ [4]. Gas temperatures are determined by Doppler-resolved IR laser absorption spectroscopy of argon metastable atoms (added in small quantity), and showing that high gas temperatures (up to 2000K) can be reached. This comprehensive data set will be presented, along with comparison to different (0D and 2D cylindrical) models

References

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