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Generation of large volume, uniform plasma with a single energy source

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Plasma nitriding is widely recognized for its ability to enhance the wear resistance of large workpieces, such as molds and tools. While the conventional approach involves utilizing the workpiece as an electrode within a DC glow discharge, alternative electrode-less methods have emerged as viable options. These methods encompass the utilization of RF power sources [2], microwave plasma, or heated filament induced electron beams [3]. Nevertheless, challenges persist with respect to achieving uniformity and processing volume.

The principal objective of this research is to advance the efficiency and effectiveness of plasma nitriding processes for large workpieces by enhancing both plasma generation uniformity and volume. To this end, the study employs a method wherein electrons are accelerated from a heated filament and directed toward nitrogen gas within the processing chamber.

The ultimate aim is to achieve uniform and large-volume plasma at low energy, thereby relying on a single electron beam source. This goal is accomplished by incorporating cylindrical electrodes within the plasma-processing region and applying a voltage to modify the orbits of electrons, leveraging the influence of the electric field created by the electrodes.

The simulation results, presented in the accompanying figures, offer a comparative analysis of plasma generation with and without the inclusion of cylindrical electrodes installed in the chamber. The color map provides insight into the electron density distribution at the radial position along the accelerating electrons, serving as a basis for evaluation.

References

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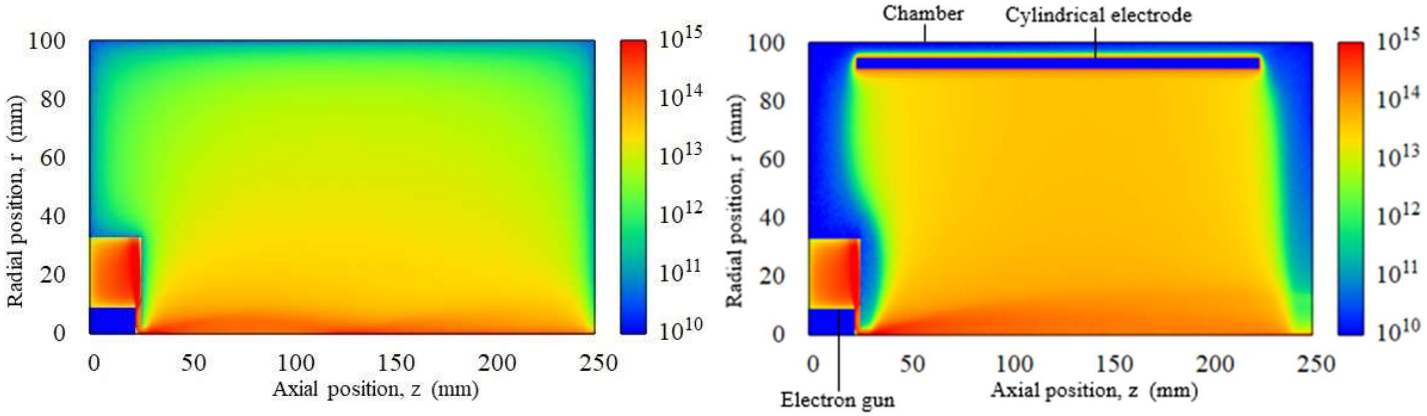

Fig. 1 Simulation results of the nitrogen plasma in the radial position along the accelerating electrons