Hollow Cathode Plasma Processes and Applications

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Hollow Cathodes are high-density plasma sources that are non-equilibrium from their principle. They are characterized by high activation and ionization degrees and can work in a broad range of parameters – pressures, powers and gas flows. They are scalable, versatile and cost effective. They enable both PVD (Physical Vapor Deposition) and PE-CVD (Plasma Enhanced Chemical Vapor Deposition) regimes and also both regimes in one hybrid mode. They can be used in various plasma-chemical processes.

Generation and performance of hollow cathodes are described both for reduced and atmospheric gas pressures. The evolution of Hollow Cathode Discharge and Hollow Cathode Arc is explained. For some metals, the discharge can even run only in target metal vapors, after closing the gas inlet.

Different applications require different arrangements of the hollow cathodes. The simple cylindrical hollow cathode can be used for local processing or for processing on inner surfaces and inside narrow tubes. Linear Arc Discharge arrangement and Magnet-in-Motion linear scalable hollow cathode enable large area processing. Combination with microwaves provides even more control of the discharge in a hybrid source. A new design with coupling of a magnetized hollow cathode with magnetron is presented. Examples of processes in PE-CVD, ionized PVD and hybrid regimes are given.

Principles and findings from performance of hollow cathodes at reduced pressures have been applied in atmospheric pressure hollow cathode based sources. Fused Hollow Cathode, Hybrid Hollow Electrode Activated Discharge utilizing teaming with the microwave antenna and Hollow Electrode Activated Discharge with aerodynamic stabilization are examples of these new concepts. They are employed in plasma surface engineering and in gas conversion. Similar designs are applied in liquids, for example for production of hydrogen and for production of high value chemicals from low value feeds.