MODELING AND CHARACTERIZATION OF A MICROPLASMA SOURCE

J. J. Narendra[1], P. Liu,[1] T. A. Grotjohn1 and J. Asmussen[1,2]
[1]*Michigan State University, East Lansing, MI 48824 USA*
[2]*Fraunhofer USA, Center for Coatings and Laser Applications, East Lansing, MI 48824 USA*

A microwave powered microplasma source is developed tested for materials processing on spatially localized areas by applying a small discharge to only the region being processed. The paper focuses on the modeling and characterization of this microplasma. A small diameter stream of plasma (less than 2 mm in diameter) is created by focusing microwave energy inside a discharge tube. The discharge then flows out the end of the tube onto the surface being processed delivering ions and reactive radicals. The diameter of the plasma stream from the tube to the material being processed is controlled by an aperture mounted at the end of the tube. The spot size of the localized plasma stream ranges from 2 mm down to 10's micrometers depending on the aperture size. The discharge is created by using 2.45 GHz microwave energy that is coupled into the discharge using a small re-entrant cavity that has a hollow inner conductor and a small capacitive gap at the end of the cavity. A processing gas mixture is fed through a 2 mm inner diameter quartz tube which is located inside the hollow inner conductor of the cavity. This tube is exposed to a high electric field at the small gap of the cavity thus generating the surface wave plasma. The length of the surface wave discharge in the tube can be extended by increasing the microwave power to the discharge so that the plasma reaches the aperture. The operating pressures range from 0.5 Torr to 10 Torr and the microwave power utilized ranges from a few Watts to 10's Watts. This paper specifically reports on measurements of the plasma power density and the plasma density of argon discharges operated in the microplasma source. Plasma density measurements are performed using a double Langmuir probe placed in the materials processing area. This paper also reports on computational modeling of the plasma discharge and the microwave excitation of the discharge. A self-consistent model of the re-entrant cavity and plasma discharge is presented with results compared to the experimental measurements.

* Work supported by NSF- DMI-0500372.