Experimental Study of Low-pressure Large-area Surface-wave Produced Discharges

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Terebessy Tibor

The recent trend in microelectronic industry has brought the demand for the low-pressure high-density plasma sources with large diameters. A promising category for the future appears to be the so-called large-area surface-wave plasma sources. The applicability of microwave surface-wave-produced plasmas to plasma processing has been investigated in large spectrum of industrial applications and some of these plasma sources are already commercially available. To solve the problems connected to the unstable behavior of surface-wave plasmas - the abrupt change of plasma density caused by standing surface-wave mode jumps in the dielectric resonator, it is inevitable to understand the discharge heating process. At low gas pressures the main mechanism of microwave energy absorption is collisionless and there are theoretical and some experimental works pointing out the importance of the collisionless electron heating at the resonance region in such discharges taking into account the inhomogeneous plasma density profile.

This work presents an experimental investigation of the discharge production and maintenance by surface waves in a large-area planar plasma source using an annular slot antenna launcher. The study is focused on the experimental observation of high-energy electrons in argon and nitrogen discharges and the self-organization of the discharge. The high-energy electrons are believed to be originating from the plasma resonance region due to non-linear wave-particle interaction and their presence indicates that the plasma resonance plays an active role in the maintenance of low-pressure surface-wave discharges. Also additional measurements for an earlier developed tuning system are given showing the possibility of the remarkable discharge control. The research in this field is oriented into technological applications of the presented tuning system.