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MICROWAVE DISCHARGES: GENERATION AND DIAGNOSTICS

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Abstract. Microwave discharges are widely used for generation of quasi-equilibrium and nonequilibrium plasma for different applications. Microwave plasma can be generated at pressures from 10^{-5} Torr up to atmospheric pressure in the pulse and continuum wave regimes at incident powers ranged between several Watts and hundreds of kW. The plasma absorbed power can be high enough and runs up to 90% of the incident power. Plasma density usually exceeds the critical n_{ec} (n_{ec} [cm^{-3}]$\approx 1{,}24 \bullet 10^{10} f^2$[GHz]). The used wavelengths of microwaves are in the range from millimeters up to several tens of centimeters and should correspond to permitted microwave frequencies for industrial, medical and scientific applications. The frequency 2.45 GHz is the most commonly used. Main advantages of microwave plasma are summarized.

Methods of microwave plasma generation are briefly reviewed (microwave waveguide plasma generators, microwave cavity plasma generators, plasma generators with plasma waves, slow wave plasma generators, plasma generators with distributed energy input, wave beam produced plasmas, electrode microwave plasma generators, initiated microwave plasmas, combined microwave and other frequencies sources plasma generators, microwave plasmas with magnetic fields).

Non-uniformity is the inherent feature of microwave plasma and this fact should be taken into account both in plasma diagnostics and in design of microwave-to-plasma applicators for specific targets. Influences of external discharge parameters on plasma uniformity are illustrated. The plasma non-uniformity defines the theoretical approaches used for processing of diagnostic data to obtain the plasma parameters. Examples of self-organization of microwave unbounded plasma is also presented.

Selected aspects of microwave plasma diagnostics by means of the probe technique, emission optical spectroscopy and high speed cameras are discussed. Peculiarities of probe measurements in microwave plasma are analyzed. Examples of results of microwave plasma diagnostics are presented together with results of modeling.

Comprehensive information on microwave discharges is contained in the Proceedings of the periodical International Workshop on Microwave Discharges: Fundamentals and Applications which is held since 1992.