TOMOGRAPHIC ANALYSIS OF PLASMA SOURCES WITH DISTORTED CYLINDRICAL SYMMETRY*

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The tomographic reconstruction of local plasma parameters for nonequilibrium plasma sources is an indispensable tool for understanding the fundamental processes and phenomena that follow the dynamics of plasmas with complex geometry. We present practical approaches that are developed on the case-to-case basis and applied to several plasma sources in our laboratories.

Any type of superconductive radio-frequency (SRF) cavity presents a plasma reactor with limited or distorted symmetry and possible presence of high gradients. Development of the tomographic method for SRF plasma analysis consists of several steps. First, we define the method based on the inversion of the Abel integral equation for a hollow spherical reactor. Second step is application of the method for the actual elliptical cavity shape. Third step consists of study of the effects of various shapes of the driven electrode. Final step consists of testing the observed line-integrated optical emission data. We will show the typical results in each step and finally in the form of correlation between experimental and calculated local plasma parameter distributions.

In another case, a detailed characterization of a plasmoid in the afterglow region of an Ar supersonic microwave cavity discharge was made. The supersonic flow was generated using a convergent-divergent nozzle upstream of the discharge region. A cylindrical cavity was used to sustain a discharge in the pressure range of 100-600 Pa. Plasmoid formation was observed as a plume-shaped structure, detached from the cavity and the distance of detachment depended on the flow conditions. The plasmoid was not observed in subsonic flow. Optical emission spectroscopy was used to observe populations of excited and ionic species in the plasmoid region. Tomographic reconstruction of the observation data revealed the surface wave discharge structure with hollow cylindrical sheath region close to the quartz tube walls. Its symmetry is gradually distorted as the surface wave is attenuated and the decreasing plasma density becomes less capable to sustain the discharge.

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