## §14. Development of Capacitively-Coupled RF Ion Source

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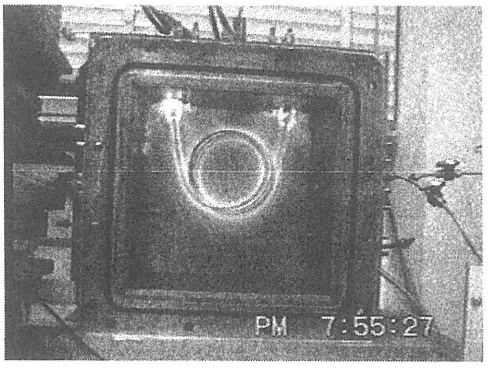
Though our final objective is to develop capacitively-coupled rf ion sources with longer life suitable for future neutral beam injectors, we started with producing an rf plasma by a 4-turn, 13-cm diameter coil immersed in a plasma. The ion source used was of magnetic multipole type, which had been used in the NBI test stand in IPP Nagoya. The filling gas was argon with pressure of 133 Pa. The coil geometry and gas condition were determined to be the same as those in our R&D experiments on rf-driven light sources[1] to get plasmas easily. The plasma was observed with a CCD camera through a transparent flange, which was attached to the source instead of an acceleration column.

A plasma was produced with an rf power of as low as several tens of watts. The camera image of the typical plasma with about 50-W rf power is shown in the figure. The rf discharge can be divided into several characteristic sections; a) a bright area surrounding the coil with thickness of about 1 cm, b) a bright area at the feed-throughs, c) a diffused plasma region outside of areas a) and c). We also observed d) occasional filament arcs between the coil turns. The section a) should be an electrostatic one due to a strong electric field along the coil winding, which is deduced from the discrepancy between the induced electromagnetic field and the actual discharge configuration. The section b) is also electrostatic between the feed-throughs and the arc chamber. The section c) is the plasma diffused from the sections a) and c). The filament arcs d) are of metallic arc type, which make chicken traces on the coil surface and shorten its life time. As wee see, the whole plasma is produced capacitively rather than inductively while we adopted a coil-like antenna. The obtained plasma is quite inhomogeneous, localized around the coil and the feed-throughs. We also evaluated the inhomogeneity of the visible light along a horizontal white line in the figure by digitizing the output of the CCD camera. The result is omitted here but will be included in a future report.

We produced plasmas with a coil-like antenna and established a measurement procedure. It is a straightforward and powerful method to look at the whole plasma with a CCD camera in order to optimize the coupling of the antenna to plasmas and thus to obtain homogeneous dense plasmas for ion sources. The behavior of plasmas with various type of antennas (both capacitive and inductive types) and with lower filling pressure will be studied in the following stage of investigation.

Reference

1) M. Monte, M. Matsuoka, and M. Kawaguchi, Proc. of the 7th Intern. Symp. on the Science & Technology of Light Sources, pp.85-86, Kyoto, 1995.




A typical rf discharge.