**Oxygen plasma diagnostic for a negative ion beam source**

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Negative ion beams have broad applications and are of particular interest in the fields of fusion and accelerators. Previous studies have focused on H- or D- ions with beam diameters on the centimeter scale or larger. However, there is less research on other ion species and beam sizes in the millimeter range or smaller, which are critical for Secondary Ion Mass Spectroscopy (SIMS) applications. Radio frequency plasmas have been shown to be effective in generating ion beams for SIMS instruments, but a highly collimated and stable ion beam is required for achieving high spatial resolution on the target.

To address the need for a highly collimated and stable ion beam for SIMS applications, we have developed a negative oxygen ion source capable of producing long-term steady-state operation using inductively coupled plasmas. The source can generate positive or negative ion beams with a few millimeters diameter. Ions are extracted from the plasma using a 2-grid system with a bias up to 10 kV. A filter magnetic field (up to 1000 Gauss) is applied at the beam exit to deflect electrons. To enhance plasma density, an additional DC magnetic field (up to 100 Gauss) is installed along the axis of the chamber. A Faraday cup with a secondary-electron suppressor plate is used to measure the ion beam current.

The compactness of the beam source imposes great challenges on measuring any plasma parameters inside the chamber. The cylindrical chamber has one end dedicated for beam extraction, with electric and magnetic connections. The other (far) end of the chamber has space for only one small window. An optical fiber is placed looking into this window, and connected to a spectrometer that measures visible lines of the oxygen plasma. Previous literatures have not provided ways to interpret line ratio of visible light emission from Oxygen plasma without additional information.

We therefore built a separate plasma chamber with similar operating regime to allow proper plasma diagnostic access. An experimental setup that includes a microwave interferometer and Langmuir probe is being developed to measure plasma density. One objective of this study is to establish a correlation between visible spectra line measurement and plasma density under identical collision conditions (same neutral pressure and electron temperature). This approach enables the estimation of plasma density in the source chamber that generates the ion beam. Additionally, this experimental setup can facilitate other diagnostic studies in the future.