

Progress on ECR2

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I. INTRODUCTION

Since the progress report of last year, the performance of the ECR2 ion source has continued to improve due in large part to vacuum improvements. At this time last year, the vacuum pressure, as measured with an ion gauge on a port external to the plasma chamber, had not declined to the low values common in other ECR ion sources. This was the case even though the source had been operated at high power for extended periods. With no gas flow and no microwave injection, it was common to see this pressure in the mid 10^{-7} torr range. Since the oxygen ions predominated the beam coming from the ion source with no gas flow, it was assumed that the background arose mainly from water vapor. A residual-gas analyzer confirmed this. The vacuum also was sensitive to the temperature of the low-conductivity water used to cool the plasma chamber. This water temperature varies slowly between 22 °C and 27 °C between seasons, and by about 1 °C through the day. The plasma chamber of ECR2 has a surface area of 0.2 m², much larger than typical sources, and it was supposed that the pumping speed to the vacuum pumps and to the extracted beam is insufficient to handle the outgassing load. Several approaches were explored to solve this problem.

II. SLOTTED EXTRACTION PLATE

In order to achieve more pumping speed on the plasma chamber, a slotted extraction plate was substituted for the original solid one. The three slots are 13 mm wide, at an outer radius and angled so that there is no direct line of sight from the interior of the plasma chamber to the puller (Fig. 1). Initially this plate seemed to be more prone to a PIG discharge in the extraction region, but after a short conditioning period

source



Figure 1. Slotted extraction plate, plasma side up, showing slots.

performance improved to the point where a source record beam of $^{16}\text{O}^{7+}$ was achieved.

III. PLASMA CHAMBER WATER-COOLING

Since the vacuum as well as the performance of the source was observed to be sensitive to the temperature of the plasma-chamber cooling water, an effort was made to lower this temperature. The low-conductivity water supply for the plasma chamber was plumbed through a heat exchanger with a supply of chilled water. This system immediately lowered the temperature of the plasma-chamber water from 27 °C to 22 °C. The background pressure was observed to drop from 4.0×10^{-7} torr to 3.0×10^{-7} torr. Figure 2 shows a comparison of charge-state spectra of argon taken with the chilled water on and off.

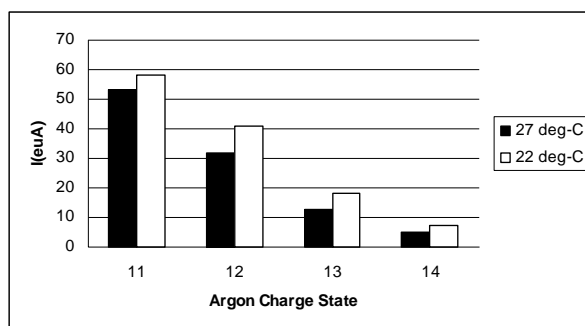


Figure 2. Argon charge states acquired with chilled water off (27 °C) and on (22 °C).

IV. PERFORMANCE

ECR2 has produced 258 eμA of $^{16}\text{O}^{6+}$ and 168 eμA of $^{16}\text{O}^{7+}$ through a 13 mm collimator. This compares with 239 eμA of $^{16}\text{O}^{6+}$ and 131 eμA of $^{16}\text{O}^{7+}$ reported last year. The microwave power level was 1.3 to 1.4 kW. New results for argon are 69 eμA of $^{40}\text{Ar}^{12+}$, 48 eμA of $^{40}\text{Ar}^{13+}$, and 27 eμA of $^{40}\text{Ar}^{14+}$. At 1.5 kW of microwave power ECR2 has produced 5.0 eμA of $^{197}\text{Au}^{35+}$. The gold was introduced via a fixed sputtering device inserted into the plasma chamber through a radial slot. For all these results, the extraction voltage was 10 kV and currents were measured after analysis on a faraday cup immediately downstream of collimation in the plane of analysis. This collimator is biased at -120 volts for suppression of back-scattered electrons.

After these results were obtained, the manifold for the turbomolecular pump was replaced. The original stainless steel manifold had been used on both older versions of the ECR1 and ECR2 ion sources and has an unnecessarily large surface area. The new stainless steel manifold has about one half this surface area and also increased pumping conductance. However, there was no opportunity to obtain new beam results before ECR2 was disassembled and moved into position above the K150 cyclotron.