Axially-mounted, high-temperature oven for ECR2

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The high-temperature oven for axial mounting on ECR2 described in the last progress report has been tested, producing beams of both titanium and aluminum. The oven was modelled on the design of an oven for the production of uranium for the ECR ion sources at the LBL 88” Cyclotron [1].

First the power supply was mounted on an insulated platform above the source (Fig. 1) and powered through an isolation transformer. Natural titanium in powder form was loaded into the tantalum crucible and the crucible clamped between the two current leads. The back-plate-oven-assembly was then inserted into the injection end of ECR2. After pumping and rf-conditioning of the ion source the oven

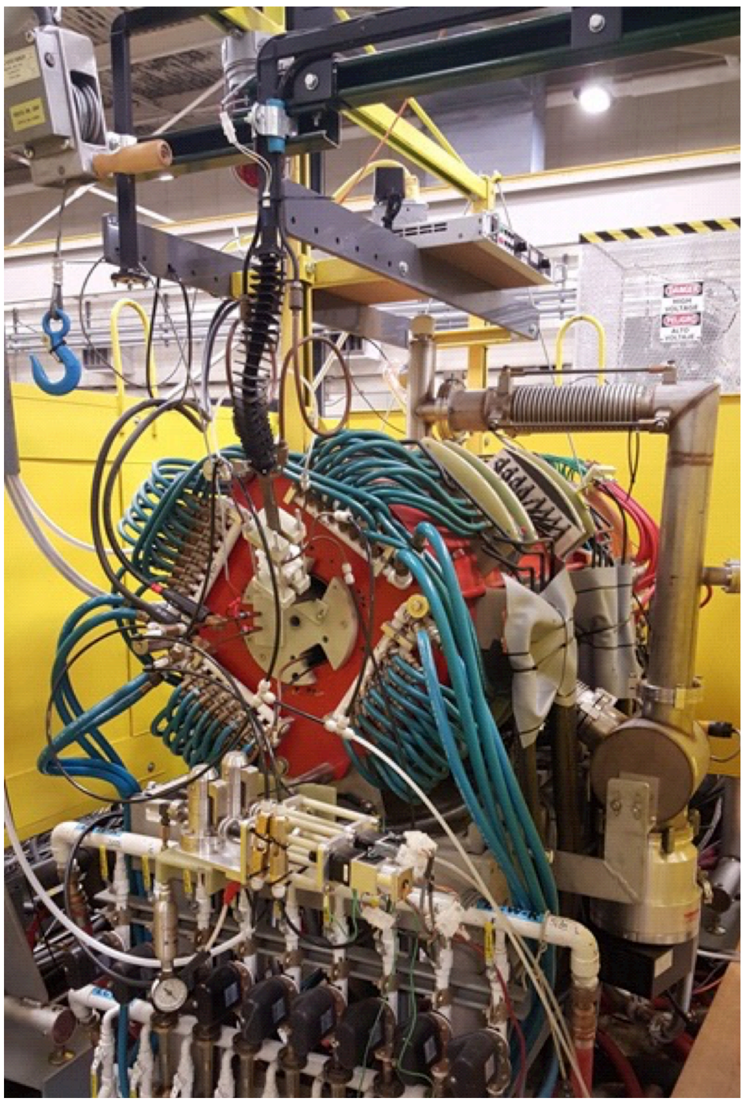

FIG. 1. The high-current supply mounted above ECR2. The water-cooled leads for the oven enter on the left-hand side of the center G-10 disk that mounts the steel plug.

current was slowly raised until a charge-state spectrum of titanium appeared. This spectrum shifted to more intensity in the higher charge-states over the course of several hours. The oven current was optimum at 130 A at 1.6 V. Before in the test chamber, titanium was observed to be depositing when the current reached 110 amperes at 1.2 volts. The temperature for a vapor pressure of 10^{-6} torr for titanium is about 1220 ºC. Fig. 2 shows one of the charge-state scans from the test.

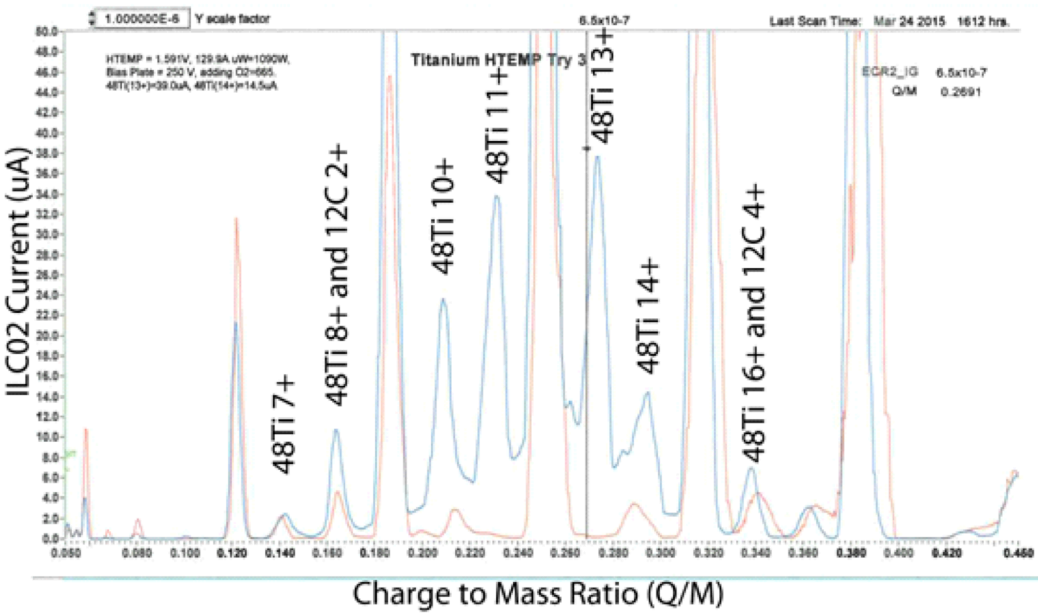

FIG. 2. Scan showing the titanium spectrum superimposed over the spectrum taken before the oven was turned on.

In another test aluminum wire was loaded into a different tantalum crucible. An aluminum charge-state spectrum was observed, but at a much higher oven current than predicted. Withdrawing the oven it was found that liquid aluminum was migrating from the crucible onto the oven heat-shields and onto the wall of the plasma chamber. Unlike titanium and many other metals, aluminum has a lower melting temperature (660 ºC) than its temperature (820 ºC) for a sufficient vapor pressure for the source. In a subsequent test, tungsten screen was inserted blocking the exit hole of the crucible, interfering with leakage of the liquid aluminum but allowing aluminum vapor to pass through. Leakage of aluminum was much reduced as was the required oven current. Fig. 3 shows the oven after removal immediately after this test. With the tungsten screen, aluminum was observed in the charge-state spectrum with oven settings as low as 106 A and 1.0V. The optimum aluminum output was observed with 110.7 A and 1.2V over the course of several hours.

Eventually the oven will be tested in the production of beams requiring even higher vaporization temperatures.

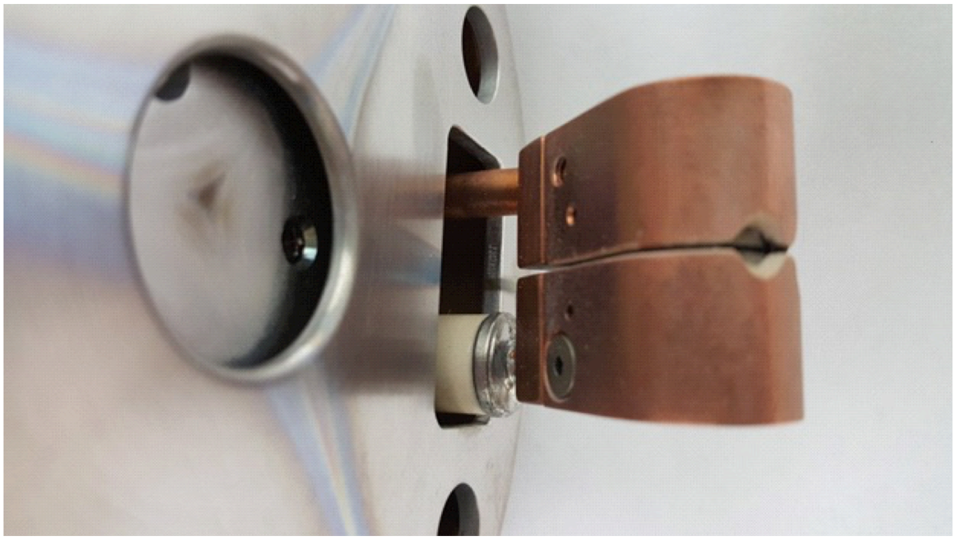

FIG. 3. The oven on the injection plate immediately after the aluminum test.

[1] T. Loew, S. Abbott, M. Galloway, D. Leitner, and C.M. Lyneis, Proceedings of the Particle Accelerator Conference, Albuquerque, NM, USA (2007), p. 1742.