Axially-mounted, high-temperature oven for ECR2

F. P. Abegglen, H. Peeler, and D. P. May

In order to satisfy the demand for K150 beams that are most easily produced using a high-temperature oven with the ECR2 ion source, an axially-mounted oven was designed, constructed and tested off-line. It was decided to mount the oven axially because of the limited space available for radial insertion. Axial insertion limits the source to only one microwave injection port, and so the old single-frequency injection flange was modified to accommodate the new oven (Fig. 1). Unfortunately, this means that two-frequency injection cannot be used with the oven mounted and that the axial steel plug must be removed when the oven is mounted or dismounted.

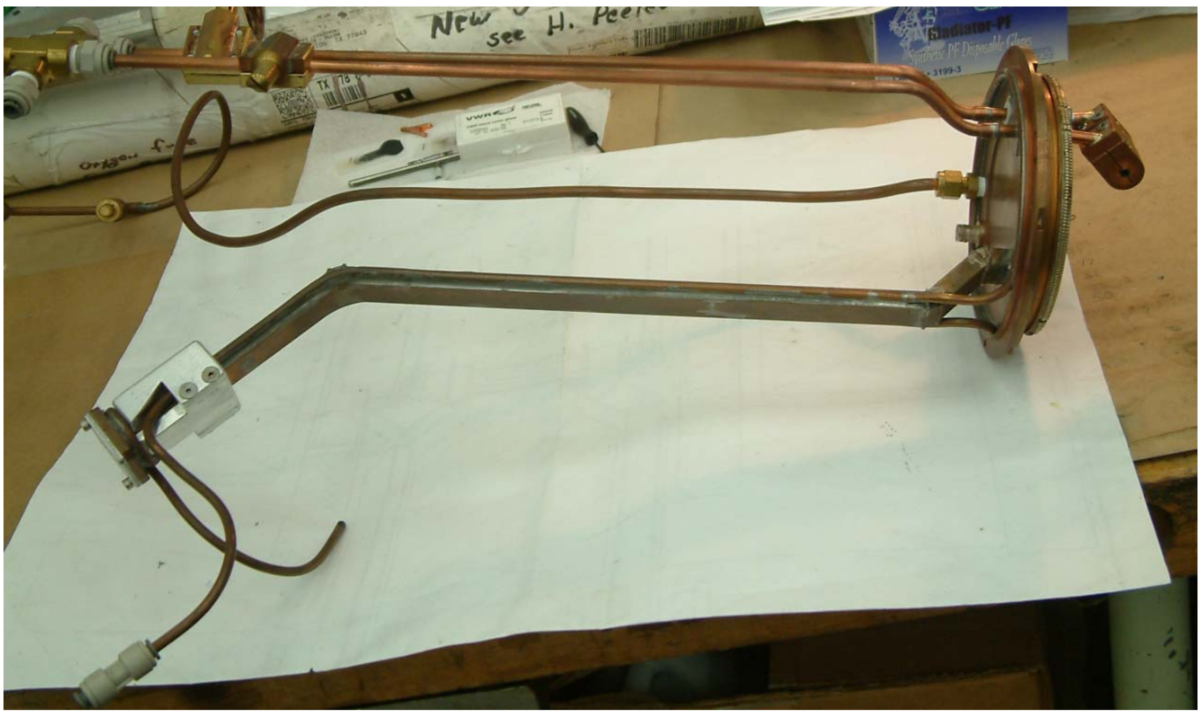

FIG. 1. The modified injection plate for ECR2. The high-temperature oven is at the top. The clamps containing the crucible are at the right.

The micro-oven that is currently used on ECR1 cannot reach sufficient temperatures in order to produce vapors of elements such as titanium, so it was decided that the more capable, high-temperature oven at the LBNL 88" Cyclotron Laboratory would be a good guide [1]. This oven was designed to reach temperatures in excess of 2000º C for the VENUS 28GHz ECR ion source. As shown in figure1 the oven is powered by two, water-cooled, copper leads. Stainless steel squirt-tubes inside the leads direct the water flow onto two copper clamps that hold the oven crucible (Fig. 2). Current flowing through the crucible provides the heat.

FIG. 2. The copper clamps and the detached, tantalum crucible.

A vacuum-chamber test stand was constructed to try out different crucible configurations. The crucible was fabricated from a 3/16” diameter, 0.0015” wall tantalum tube with tantalum plugs. After testing several configurations of the crucible, four 1/8” diameter holes were drilled into each end of the crucible outside of the plugs in an effort to concentrate the heat flow in the center. Vapor escapes from a 1/16” diameter hole drilled in the middle. Titanium was loaded into the crucible for a testing. Fig. 3 shows results from a successful test. A thin film of titanium was deposited onto a glass slide placed at the vapor outlet of the oven. Titanium was observed to be depositing when the current reached 110 amperes at 1.2 volts. The power supply was voltage controlled. As the oven heated up and evaporated more titanium, the power supply voltage was gradually raised to 1.4 volts in order to maintain a current of 100 amperes. The oven continued to produce vapor for a week. After these tests no evidence of heating the walls of the vacuum chamber was observed, a critical aspect in considering possible heat-damage to the permanent magnets in the ECR2 ion source.

The next step is to mount the oven onto ECR2 and observe its behavior in the production of beams of titanium and eventually in the production of beams requiring even higher vaporization temperatures.

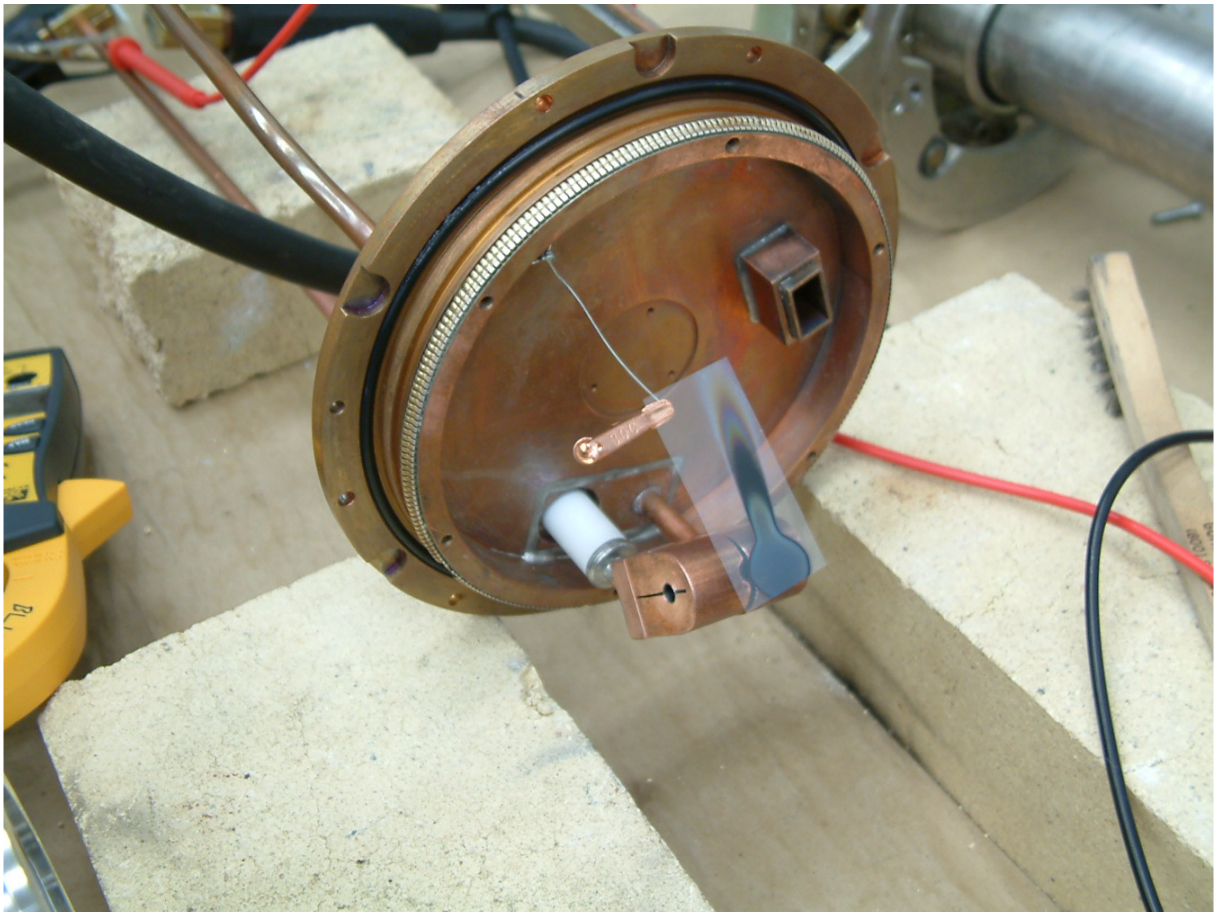

FIG. 3. Results of titanium test – titanium film on glass slide after one week.

[1] T. Loew, S. Abbott, M. Galloway, D. Leitner, C.M. Lyneis, Proceedings of the Particle Accelerator Conference (PAC07), Albuquerque, New Mexico, USA (2007) p. 1742.