Operational test of micro-oven for ^{48}Ca beam†

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In order to supply a high-intensity and stable ^{48}Ca beam from the 18-GHz electron cyclotron resonance ion source (ECRIS),[1)] we have been conducting operational tests of a micro-oven for the ^{48}Ca beam.

The structure of the micro-oven and the method to produce the ^{48}Ca beam are described in Ref. 2.

In these test experiments conducted at the 18-GHz ECRIS, the material used was the element ^{40}Ca. The beam intensity was measured using a Faraday cup installed at the exit of the analyzing magnet. Figure 1 shows the charge distribution of Ca ions when the beam intensity of 60 electric μA was obtained for Ca^{11+}. In the test experiment from which this spectrum was obtained, a hot liner was installed into the plasma chamber, and a negative voltage bias was not applied to the micro-oven (both cases are mentioned below).

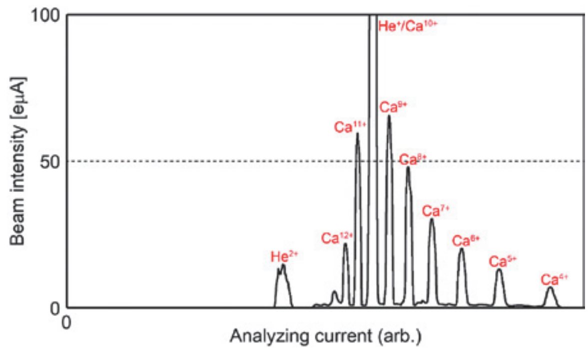

Fig. 1. Charge distribution of calcium ions.

For the supply of metallic beams, several facilities use a so-called "hot-liner"[3, 4)] to reduce the material consumption rate. In this method, the inner surface of the plasma chamber is thermally decoupled from the cooling water jacket. The inner surface is heated by the plasma to enable the metallic atoms to re-evaporate from the inner surface. Fig. 2 shows the results of one of the long-term experiments in the cases in which the hot liner was not installed (without the hot liner) and installed (with the hot liner) in the plasma chamber. The beam intensities for Ca^{11+} are shown. In the case without the hot liner, the beam intensity was not maintained at a constant value. In the case with the hot liner, the beam intensity was maintained at 30 electric μA. The amounts of calcium placed in the crucible and subsequently consumed were 252 mg and 230 mg, respectively, for the case without the hot liner, and 246 mg and 105 mg, respectively, for the case with the hot liner. The consumption rates without and with the hot liner were estimated to be 0.88 mg/h and 0.44 mg/h, respectively.

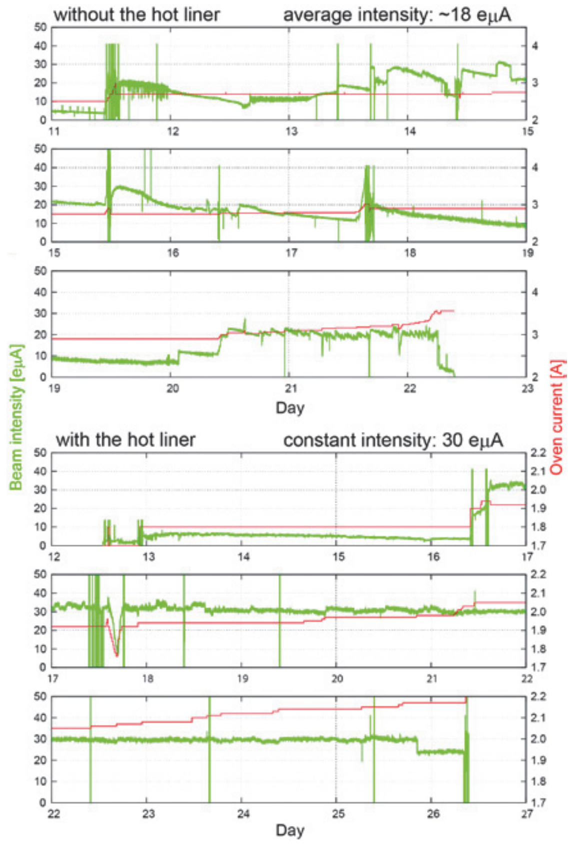

Fig. 2. Long-term experiment results when the hot liner was not installed and when it was installed in the plasma chamber.

One method to enhance the beam intensity is the "biased disk" method.[5)] In this method, a negatively biased metal disk is installed in the plasma chamber. We investigated the effect of a negative bias applied to the micro-oven itself under the various oven positions. Beam intensity enhancement of up to 20% was observed. An effect similar to a biased disk was confirmed.

References

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