

Contribution of Atomic Hydrogen Flux on H^- Ion Beam Extracted from a Negative Hydrogen Ion Source

Yuji SHIMABUKURO, Daisuke KUWAHARA, and Motoi WADA

Graduate School of Science and Engineering, Doshisha University



October 16th, ICIS 2017

INTRODUCTION

Contemporary negative hydrogen (H^-) ion sources are operated with cesium ovens, and some part of the H^- ion current extracted from the source is believed produced at the surface of the biased plasma electrode. The principle mechanism of the H^- ion current production can be due to the reflection of atomic hydrogen, but this hypothesis has not been directly confirmed in the actual ion source operating condition yet. An atomic hydrogen source is attached to a multicusp type H^- ion source to see the effect upon the extracted negative ion current. The atomic beam source produces hydrogen beams of low temperature atoms by capacitively exciting a plasma in a pyrex tube. The influence of low temperature atomic hydrogen injection to the plasma grid on H^- production has been investigated.

EXPERIMENTAL DETAILS

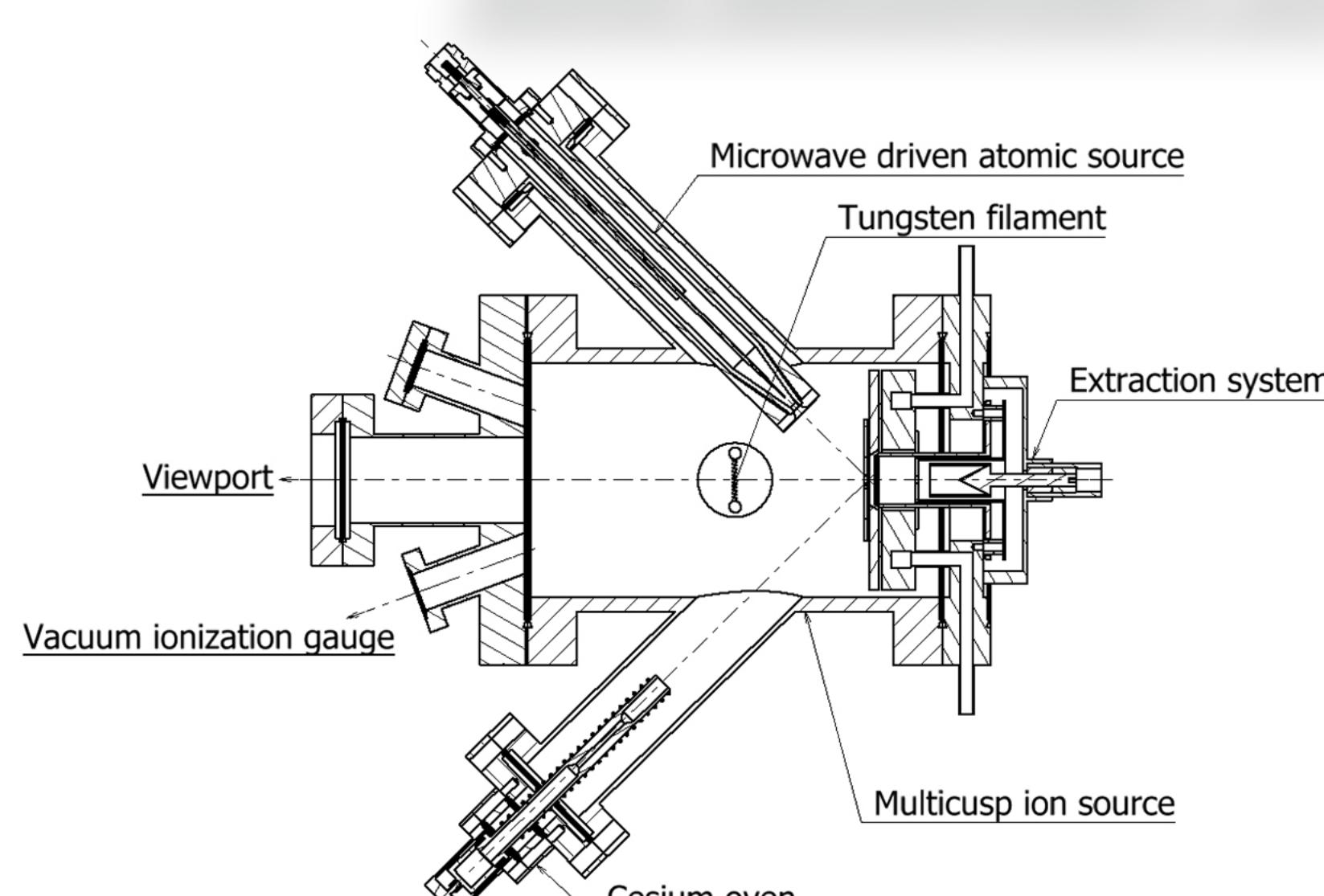


Fig. 1. Cross-sectional view of the multicusp type ion source which ignites by hot cathode discharge has negative hydrogen ion extraction system with magnetic filter and capacitively excited microwave driven atomic source.

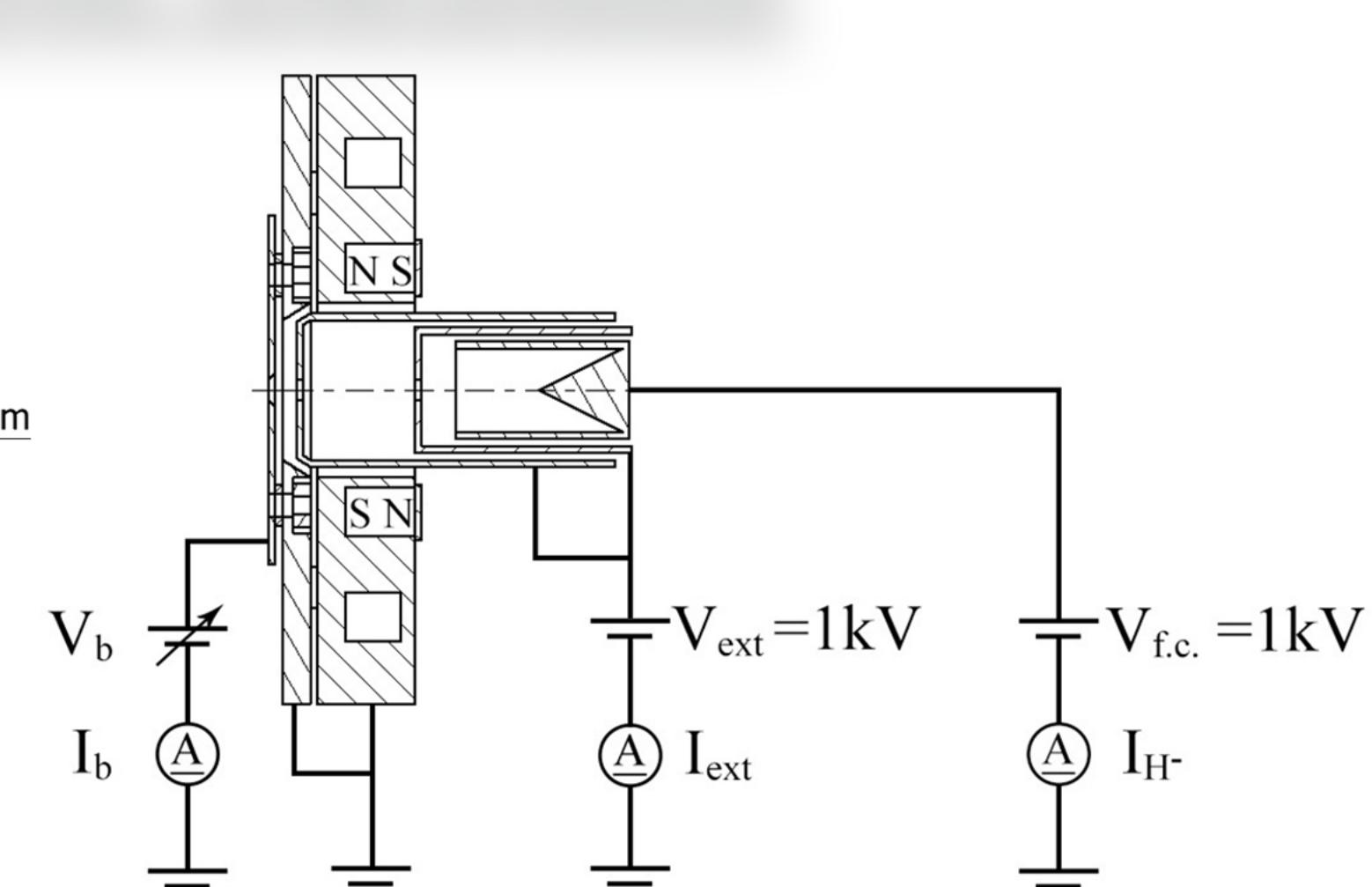


Fig. 2. A schematic drawing of the H^- measurement circuit by a Faraday cup.

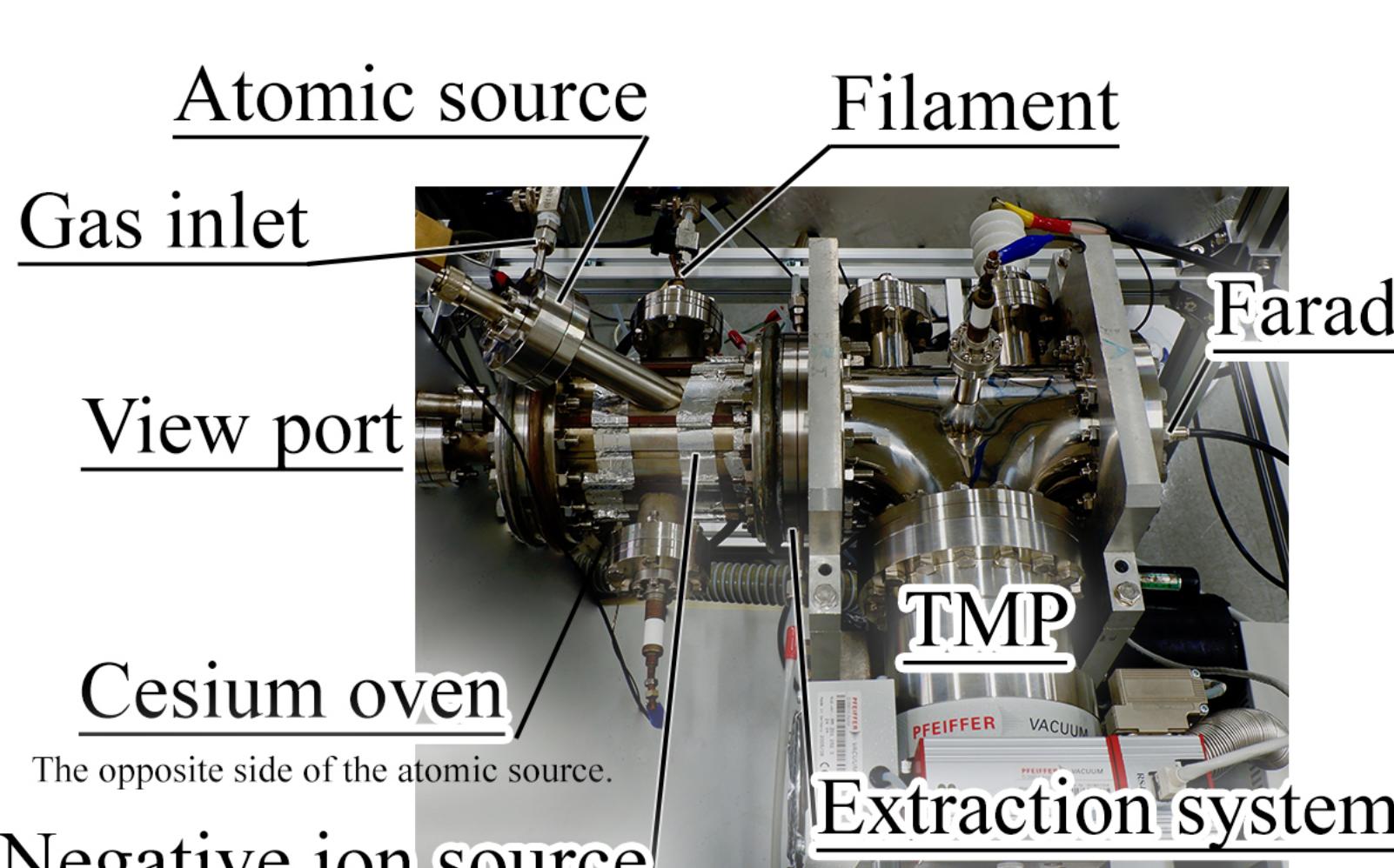


Fig. 3. A photograph of the experimental setup.

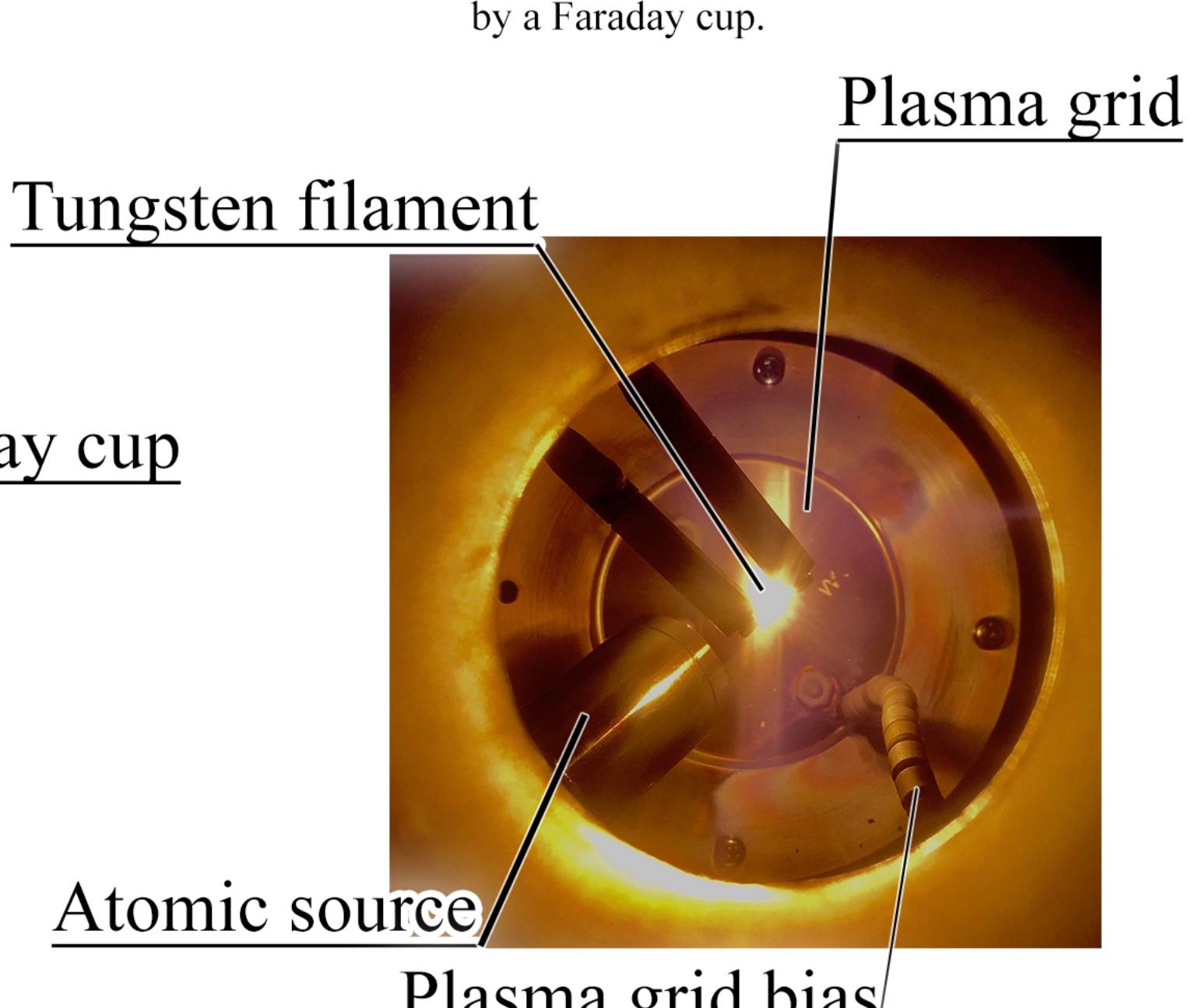


Fig. 4. A photo showing the components arrangement.

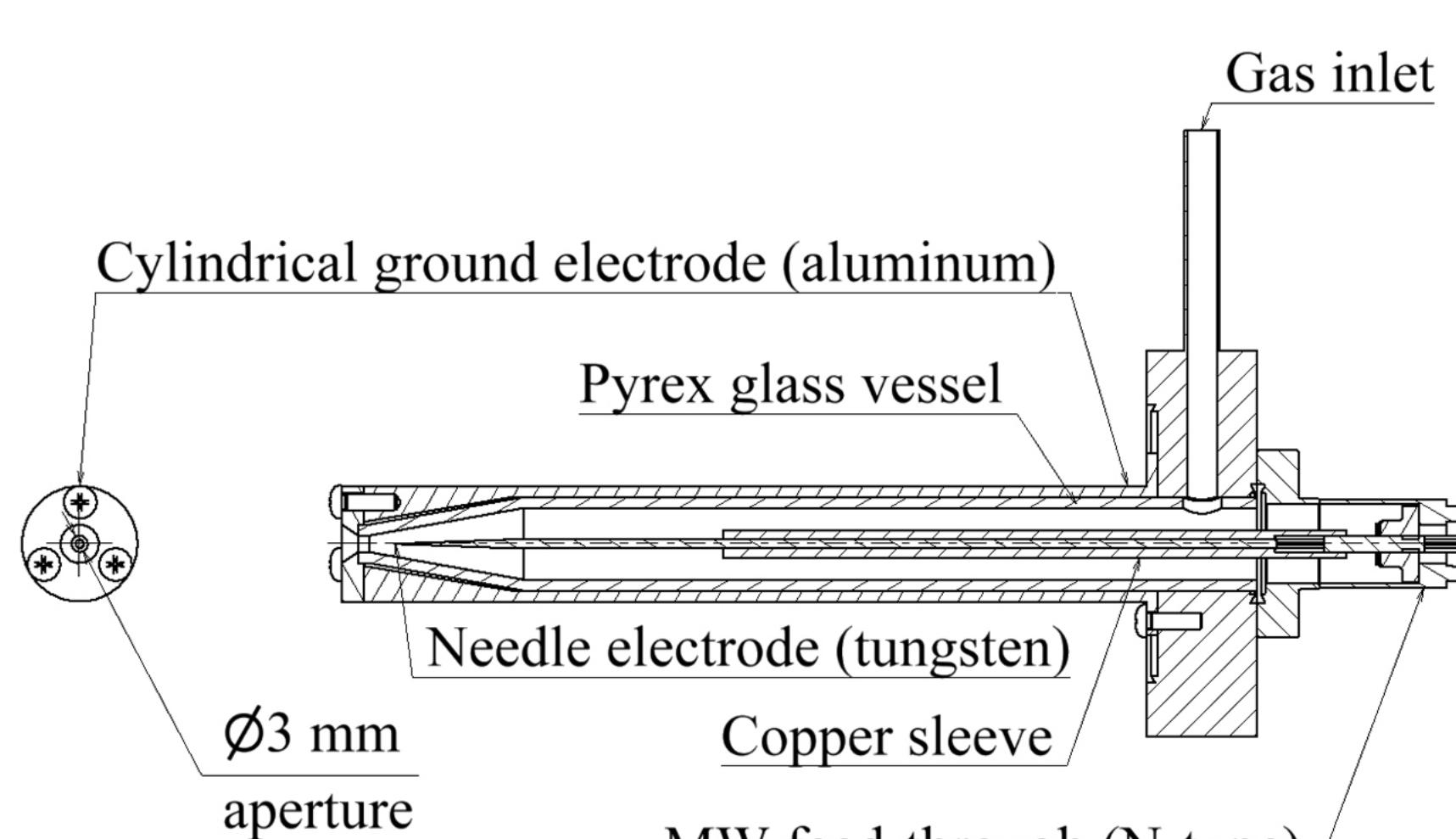


Fig. 5. A sectional view of the capacitively coupling type microwave driven atomic source apparatus.

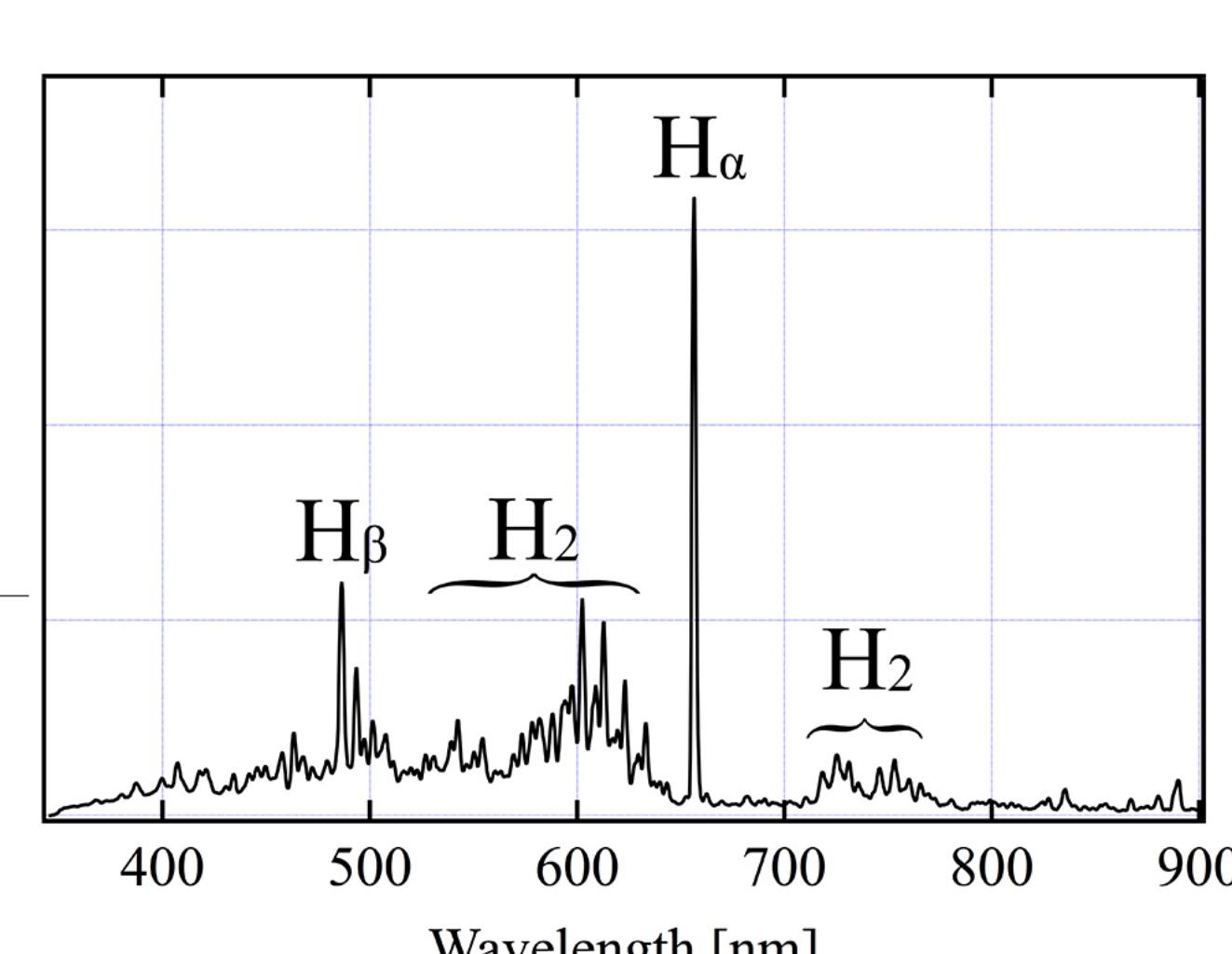


Fig. 6. An optical emission spectrum of hydrogen-CCP measured by USB-2000+ at the 1.5E-1 Pa condition.

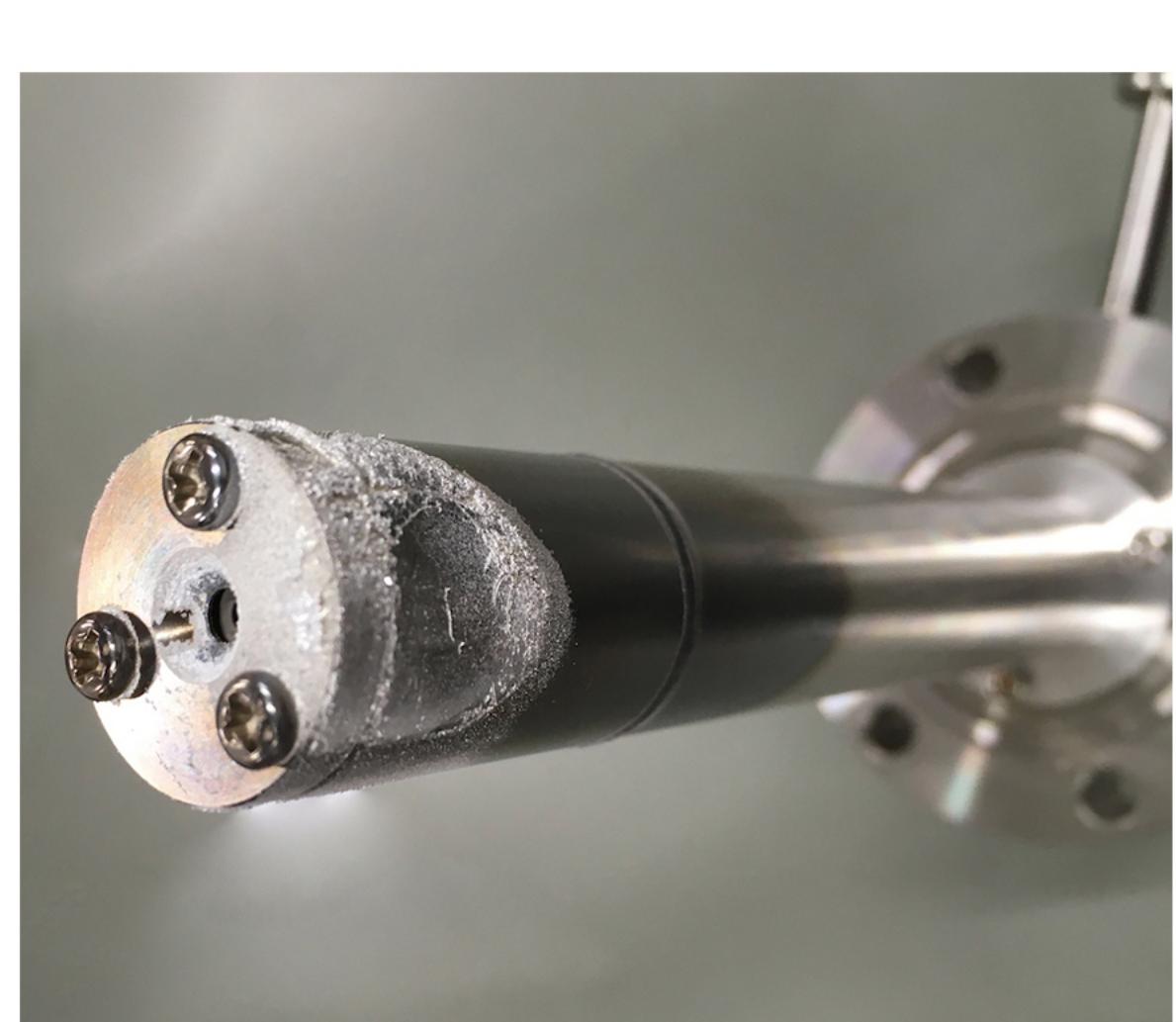


Fig. 7. A picture of the atomic source tip after the experiment.

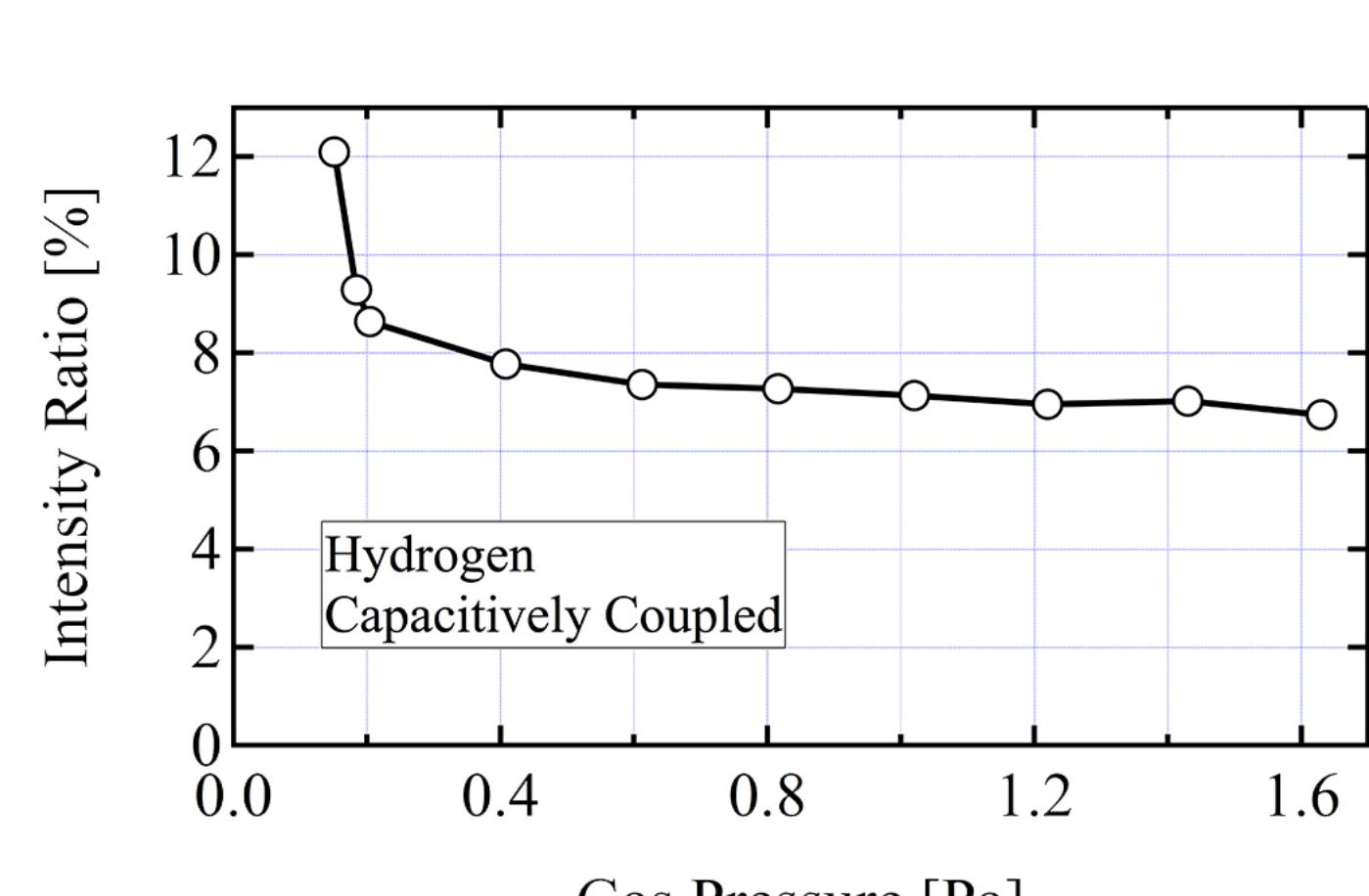


Fig. 8. An atomic intensity ratio of the CCP source.

RESULTS

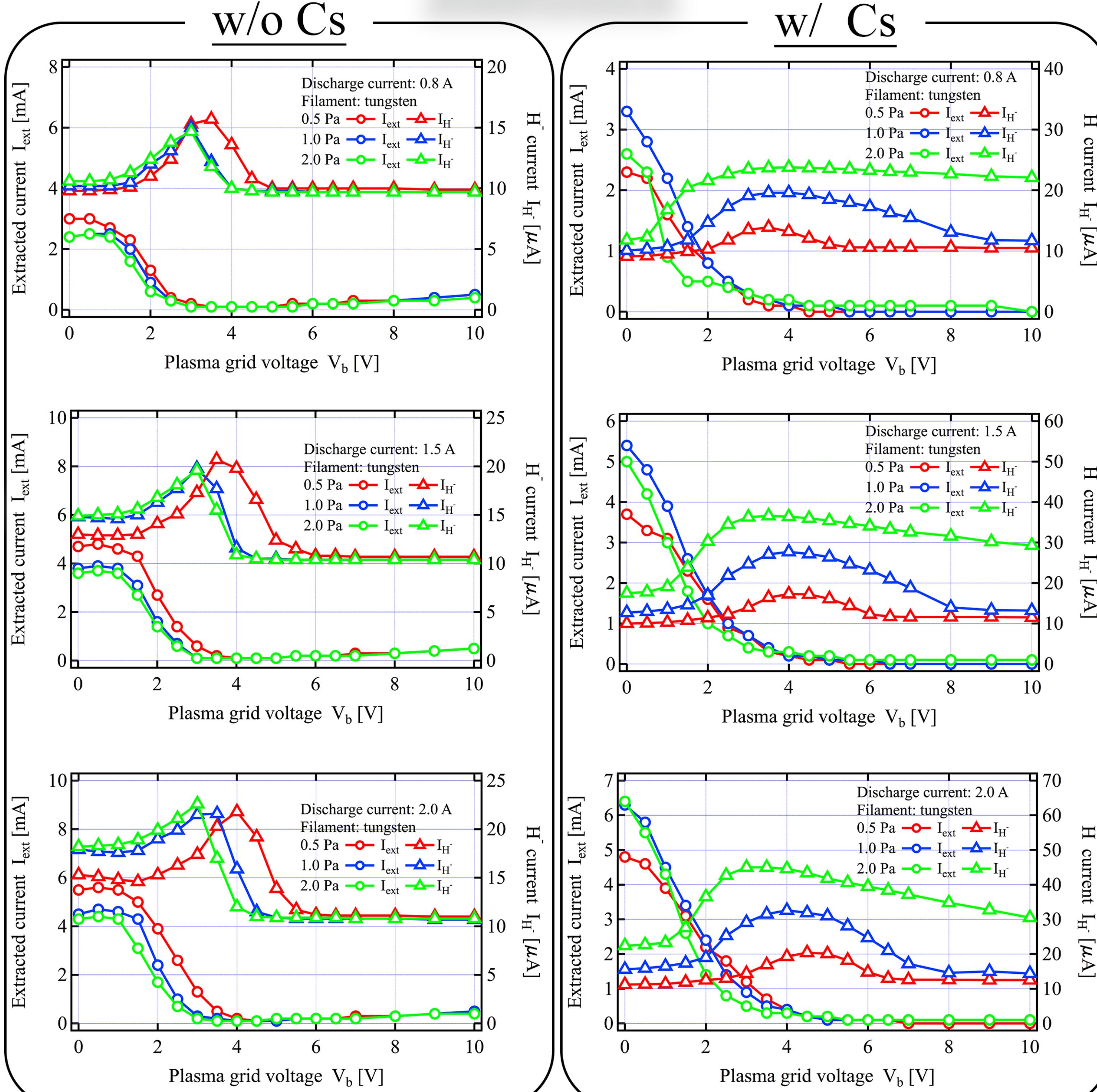


Fig. 9. Extraction characteristics of electron and H^- current with respect to the plasma grid bias voltage.

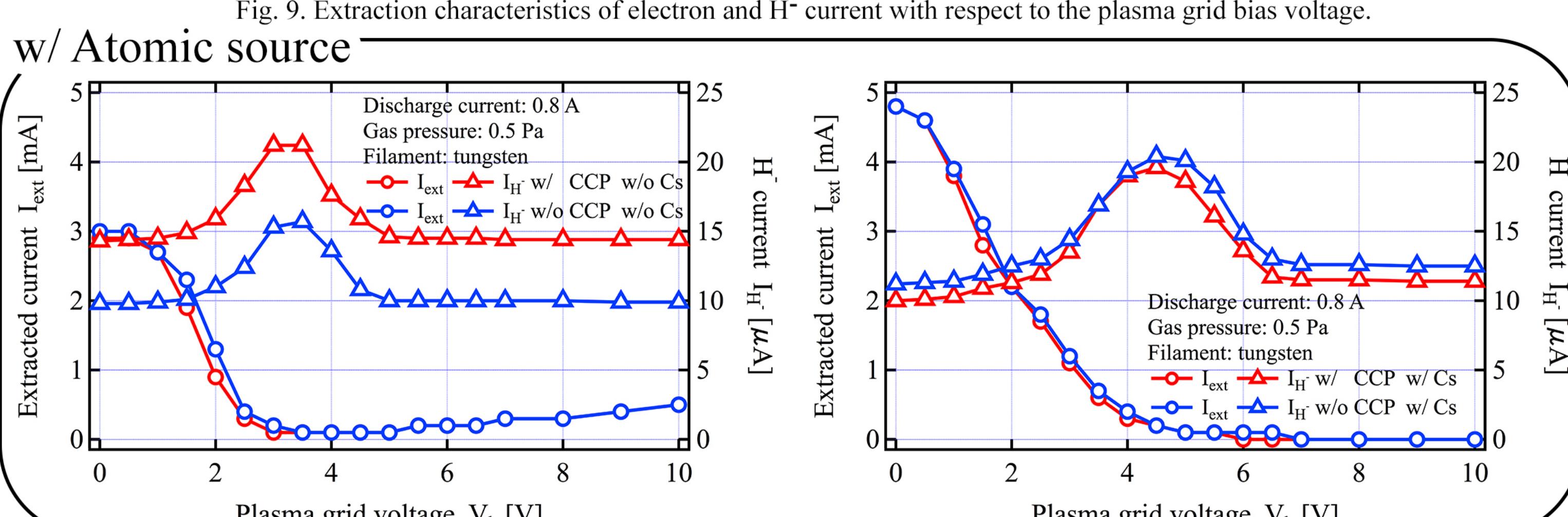


Fig. 10. The influence on extracted H^- current of microwave CCP injection.

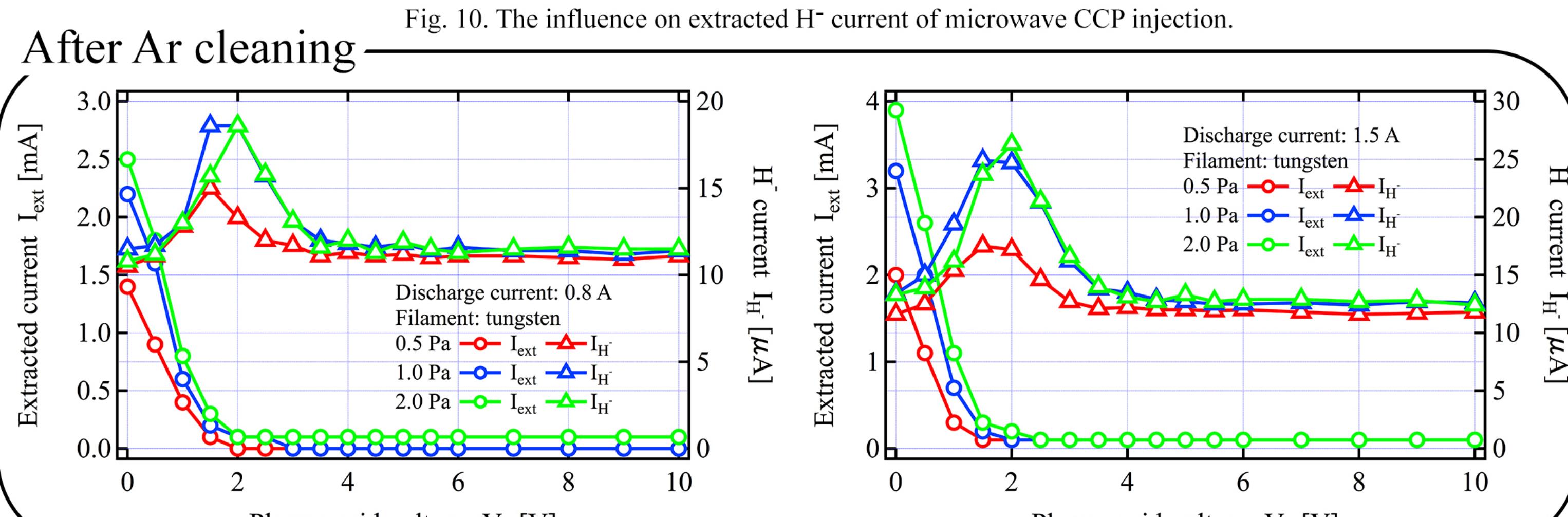


Fig. 11. Characteristics of extracted H^- and electron current after the Ar sputtering.

SUMMARY

Under a cesium-free condition, CCP injection to the negative ion source enhanced the H^- production rate considerably. The increase of H^- could be caused by volume production because the surface production process should not work in a non-cesiated situation. As the microwave atomic source emits not only atoms but also electrons and positive ions due to its magnetic field-free structure, electrons and excited molecules enhance H^- volume production. While the CCP injection to the negative ion source is a useful way in the cesium-free condition, CCP injection to the cesiated source showed an opposite effect of cesium-free condition. These results indicate the H^- quantity generated in volume production by plasma from CCP is less than the quantity of H^- destruction by atoms, positive ions, and fast electrons from CCP. Experimental results imply the atomic temperature of CCP is insufficient to realize the surface production since the threshold energy is believed to be 0.75 eV: ϕ_{w-E_A} .