

# Extraction of Negative Hydrogen Ions through a Plasma Electrode Covered by a Ta or Ti Foil

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## INTRODUCTION

Negative hydrogen ion ( $H^-$ ) current and electron current extracted from a negative hydrogen ion source show different characteristics against the change in plasma electrode bias depending upon the material covering the plasma electrode surface. Usage of Ta filament as the hot cathode in a negative ion source improves negative hydrogen ion production [1]. Ta vapour deposition on a plasma electrode surface may absorb more efficiently the hydrogen atoms, which destroy the hydrogen negative ions by associative detachment [2]. Titanium (Ti) and Ti alloys also absorb hydrogen atoms in high temperature [3]. This study aims to verify Ta cathode effectiveness in a negative hydrogen ion source by comparing to Ta and Ti foil.

## EXPERIMENTAL SETUP

**Schematic diagram of experimental setup**

**Detail diagram of extraction system**

**Foil on a plasma electrode**

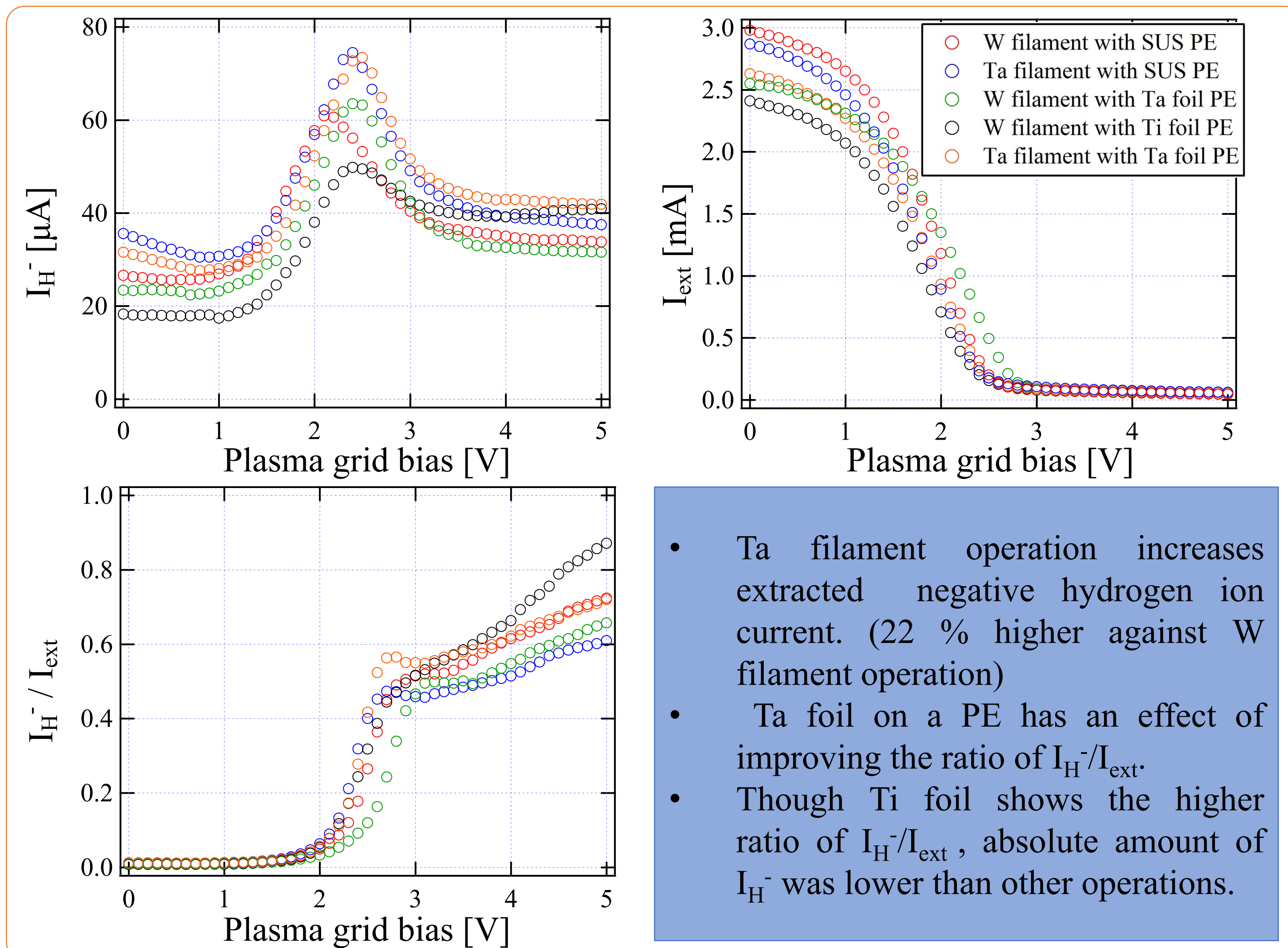
<p><b>chamber</b></p> <ul style="list-style-type: none"> <li>height : 200 mm</li> <li>diameter : 150 mm</li> <li>material : SUS304</li> </ul> <p><b>plasma electrode</b></p> <ul style="list-style-type: none"> <li>diameter : 145 mm</li> <li>extraction hole dia. : 5.0 mm</li> <li>material : SUS304</li> </ul>	<p>bias : -5 ~ +5 V</p> <p><b>floating electrode</b></p> <ul style="list-style-type: none"> <li>diameter : 145 mm</li> <li>center hole dia. : 30 mm</li> <li>material : SUS304</li> </ul> <p><b>discharge status</b></p> <ul style="list-style-type: none"> <li>discharge voltage : 80 V</li> <li>discharge current : 1.0 A</li> </ul>	<p>gas : <math>H_2</math></p> <p>gas pressure : 0.5 Pa</p> <p><b>filament</b></p> <ul style="list-style-type: none"> <li>material : W or Ta</li> <li>diameter : 0.5 mm</li> <li>length : 80 mm</li> </ul> <p><b>foil</b></p> <ul style="list-style-type: none"> <li>thickness : 0.1 mm</li> </ul>	<p>shape : 50mm x 50 mm</p> <p><b>extraction experiment</b></p> <ul style="list-style-type: none"> <li>extraction voltage : 800 V</li> <li>Faraday cup voltage : 800 V</li> </ul> <p><b>probe experiment</b></p> <ul style="list-style-type: none"> <li>probe ingredient : W filament</li> <li>probe diameter : 0.35 mm</li> <li>probe length : 12 mm</li> </ul>
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**shape : 50mm x 50 mm**

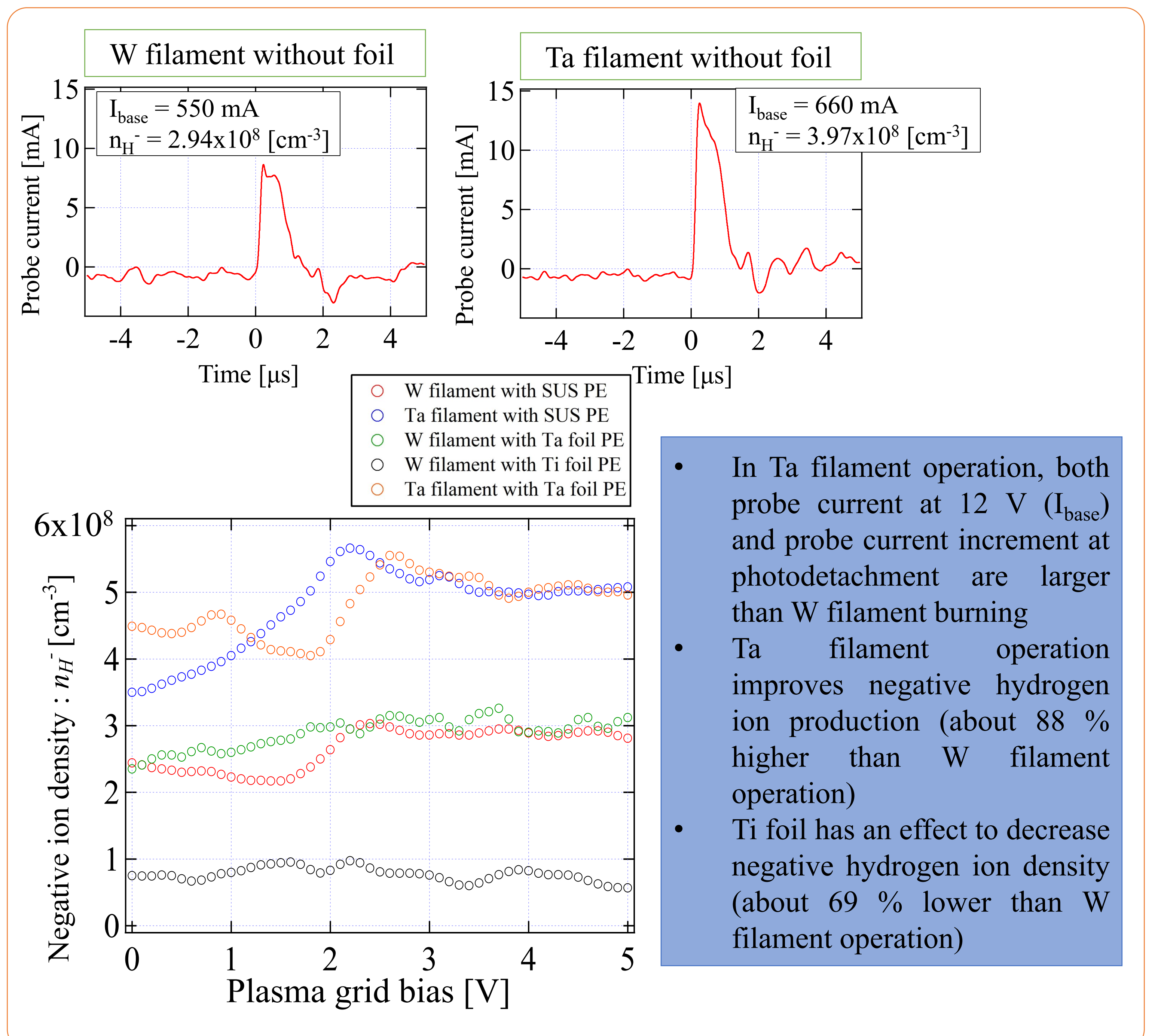
**photodetachment experiment**

- shape : L-shape
- distance between the probe and the plasma electrode : 12 mm
- probe voltage : 12 V
- laser length : 1064 nm
- average 256 data

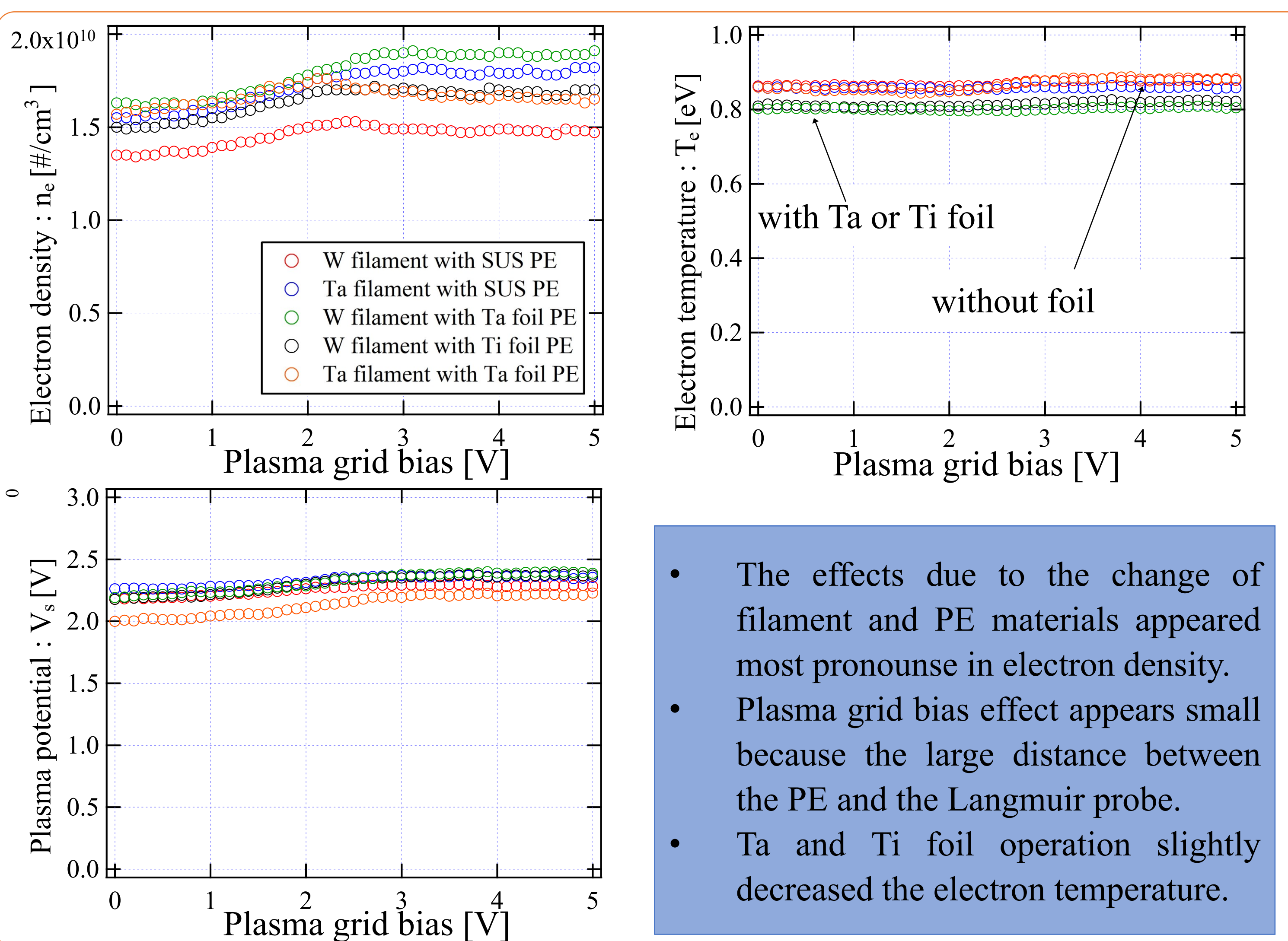
## EXTRACTION EXPERIMENT



## PHOTODETACHMENT EXPERIMENT



## PROBE EXPERIMENT



## SUMMARY

Ta covering the plasma electrode surface enlarges negative hydrogen ion current. A hot cathode made of Ta increases the density of negative hydrogen ion in a negative ion source. Ta foil on a plasma electrode make negative ion current – electron current ratio larger by 13 %. At Ta filament operation, increment of negative ion density against W filament without foil operation (88 %) is larger than the increment of negative ion current (22 %).

## REFERENCE

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- M. Bacal and M. Wada, AIP Conf. Proc. **1869**, 030025 (2017)
- A. Lopez-Suarez, J. Rickards, R. Trejo-Luna, Int. J. Hydrogen Energy, **28**, 1107-1113 (2003)