Characteristics of extracted negative ion beam using electron emitters on the Cs-free negative ion source TPDsheet-U

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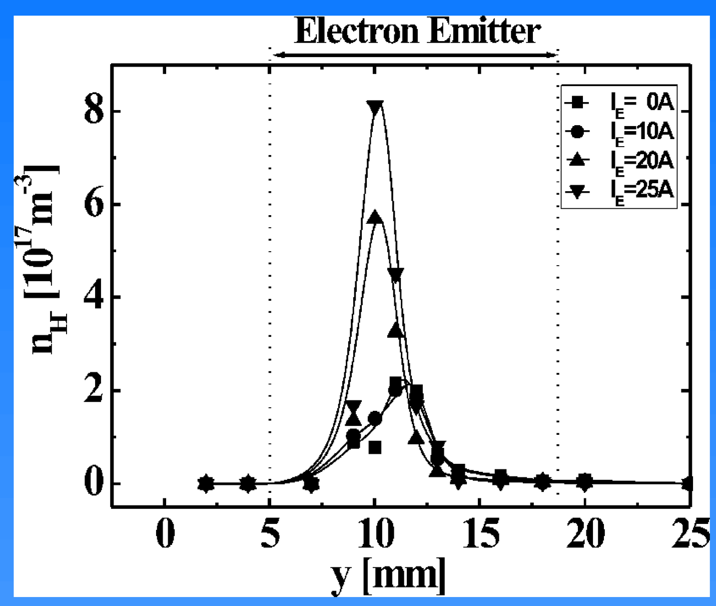
Introduction

Negative ion source performance at ITER NBI and TPDsheet-U [1,2]

	ITER-NBI		TPDsheet-U
	D-Beam	H-Beam	Single(H-)
Cs seeding	W/	W/	W/O
Extracted Current Density	29 mA/cm^2	33 mA/cm^2	~ 7.5 mA/cm^2
Current Ratio I_e/I_{H^-}	≦1	≦0.5	~ 2

TPDsheet-U is a cesium-free negative ion source using the volume production. In our laboratory, in addition to reducing the negative ion current ratio I_e/I_{H^-}, it is necessary to increase the extracted negative ion current density

Electron Emitter [3]



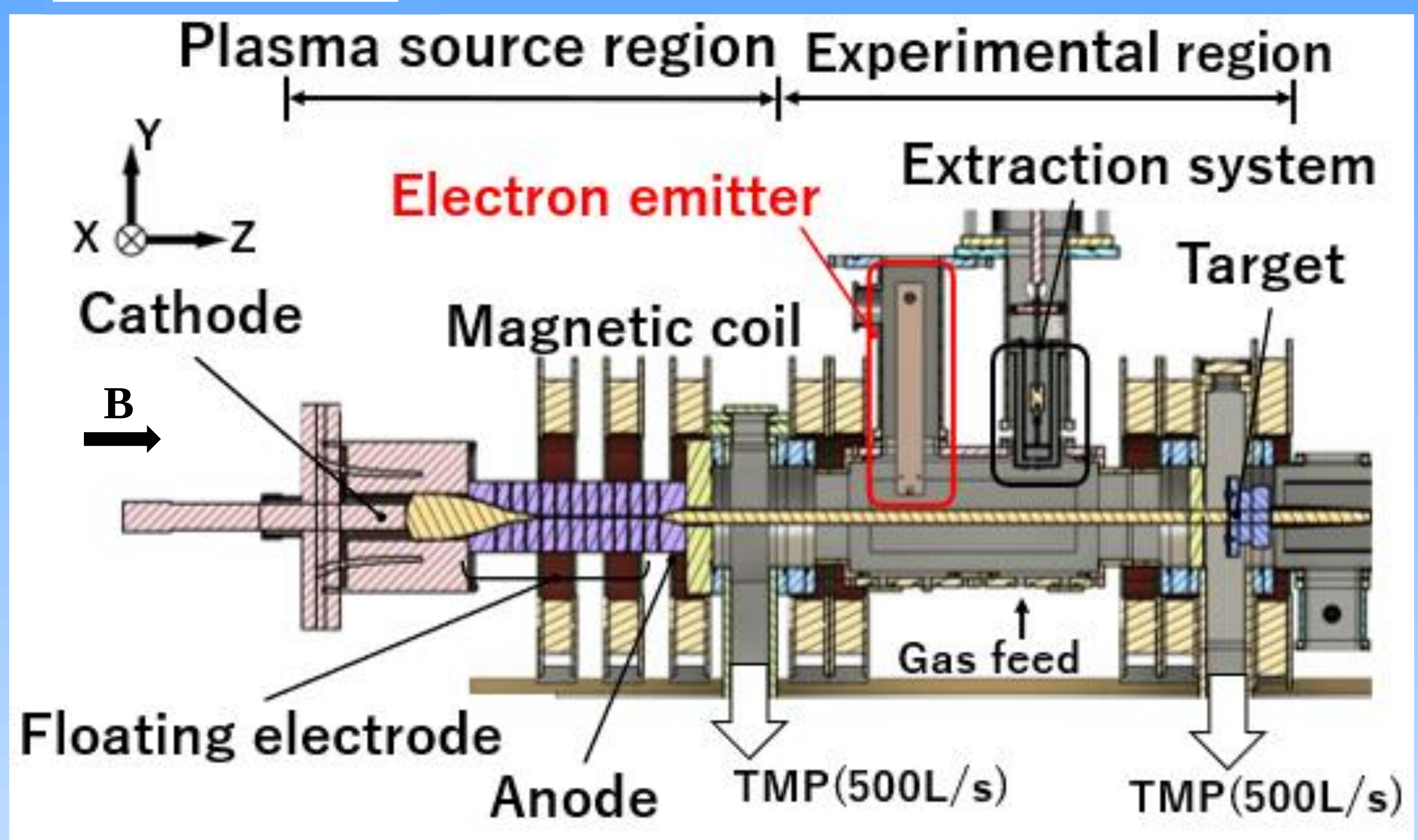
The spatial profiles of n_{H^-} in the y-direction at various emission current of electron emitter I_E. The I_E changes (■)0, (●)10, (▲)20, (▼)25 A.

About left graph:

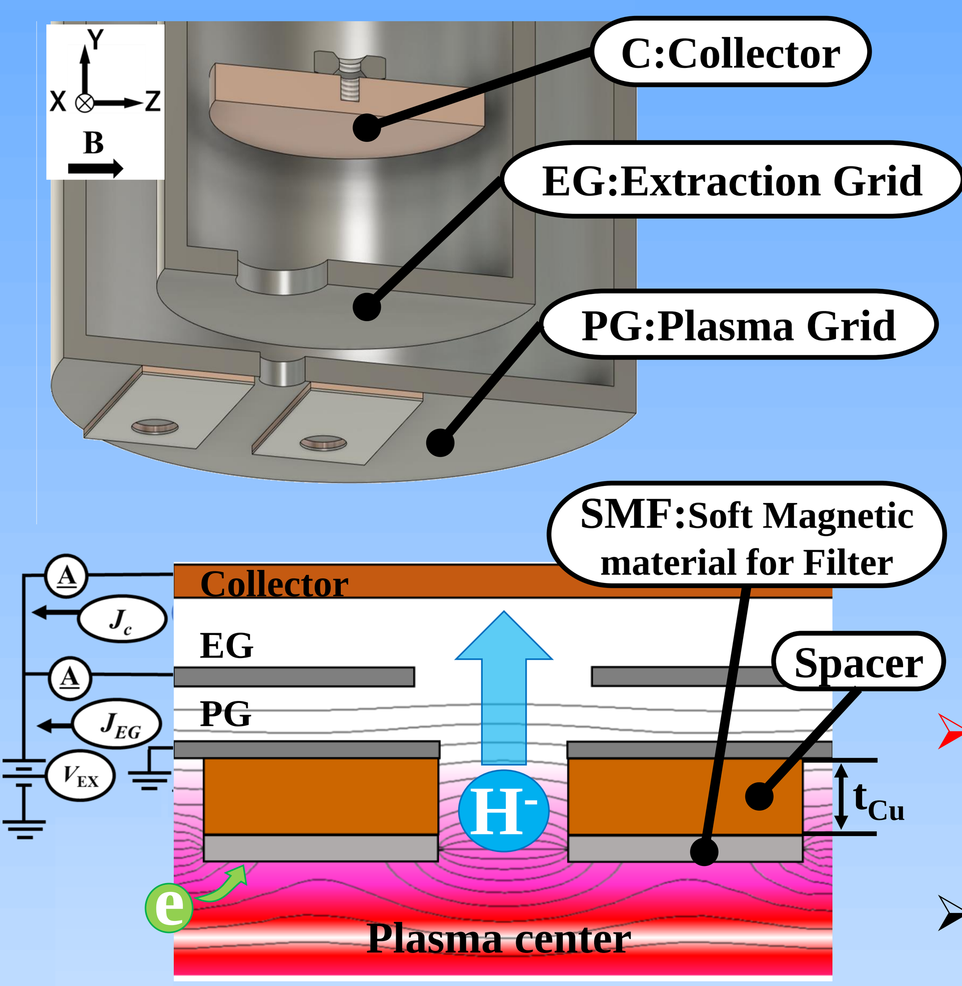
- When the value of IE changes from 0 to 25 A, TF increases to 1400 K.
- At the same time, the value of n_{H^-} increases from 1.0 × 10^{17} m^{-3} to 8.0 × 10^{17} m^{-3} with increasing in IE.

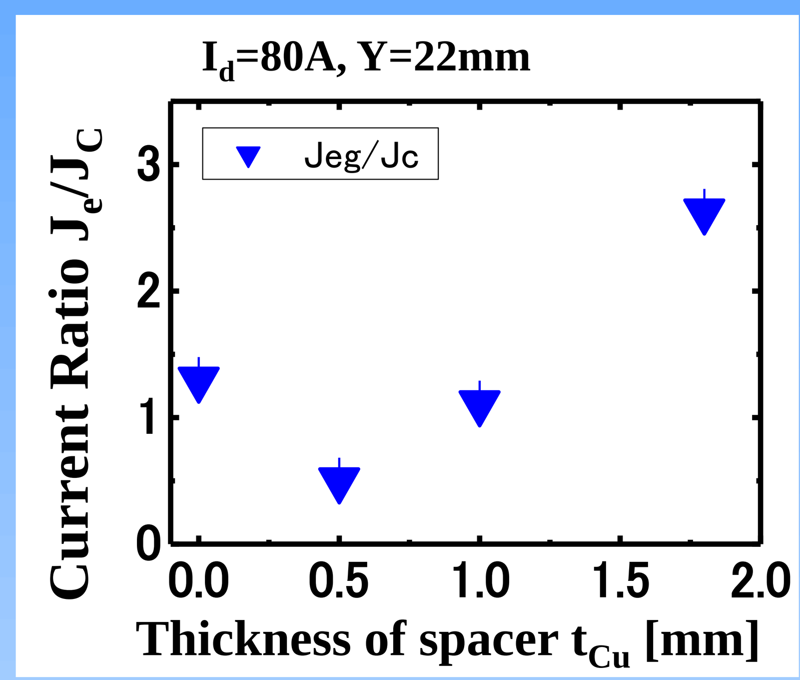
In this poster, we report experimental results when using an electron emitter as a method to increase the extracted current density.

TPDSheet-U



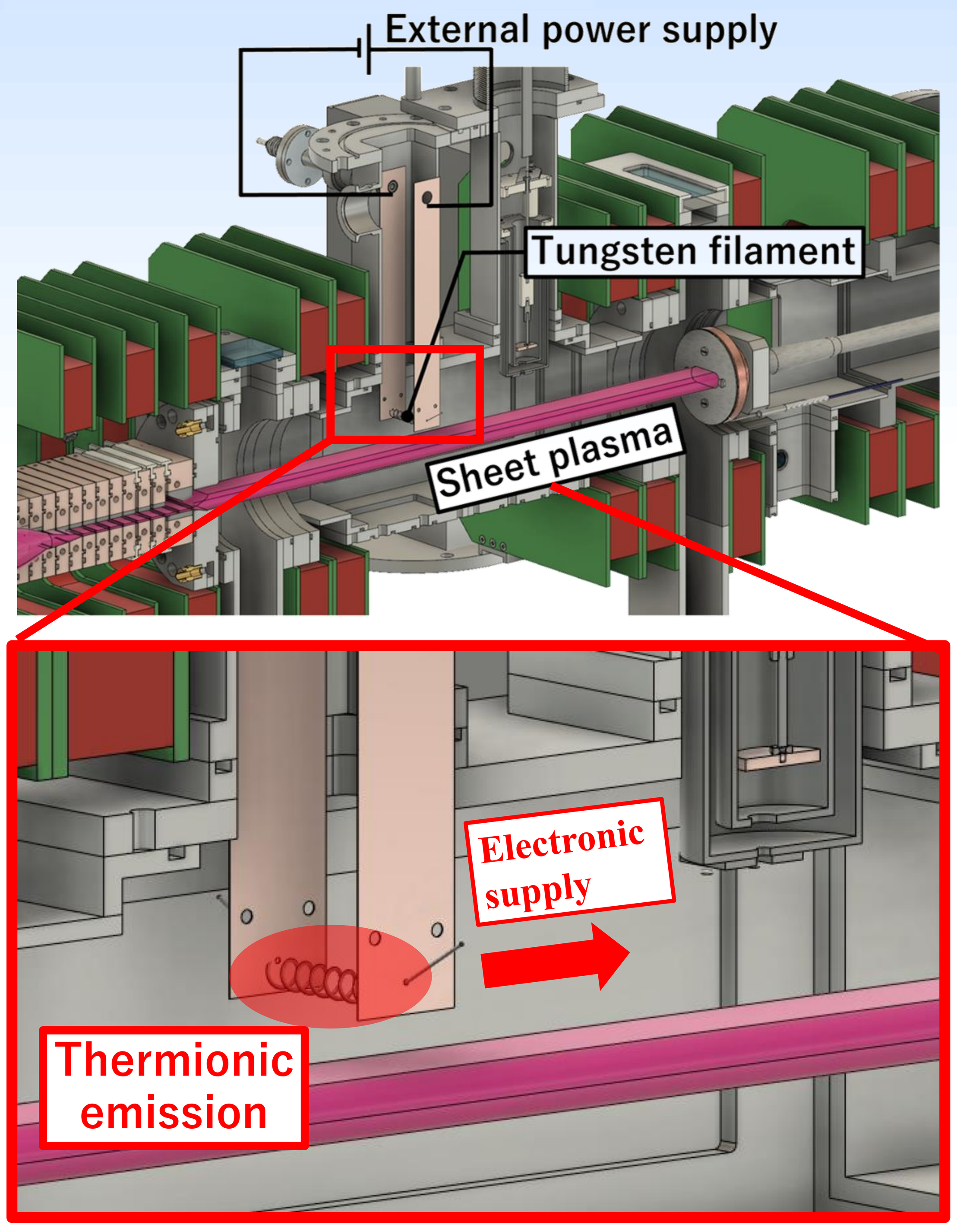
Extraction system





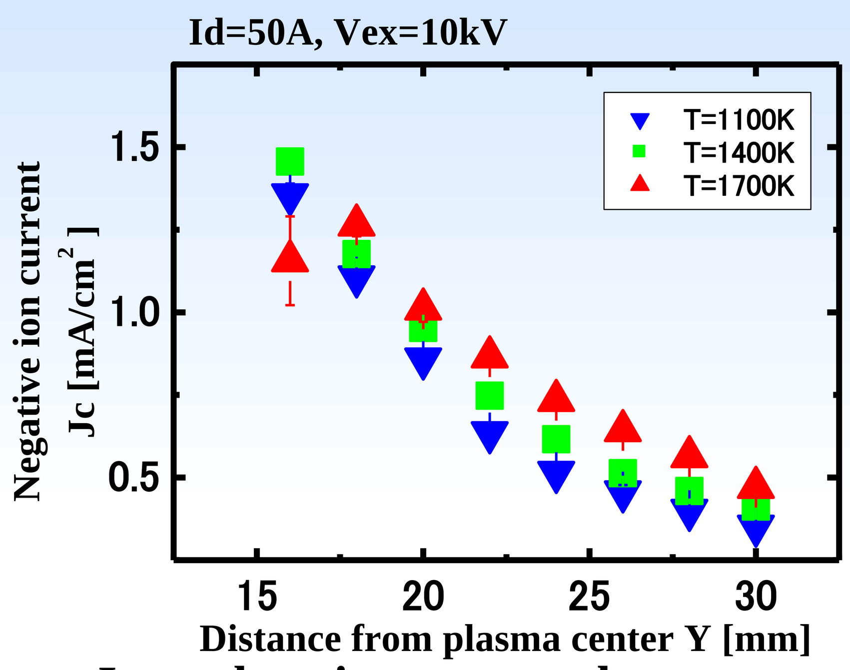
- Coextracted electrons are trapped in the local curved magnetic field generated by the installation of SMF
- Manipulate the pullout performance by inserting a spacer between PG and SMF [4]

New Electron Emitter



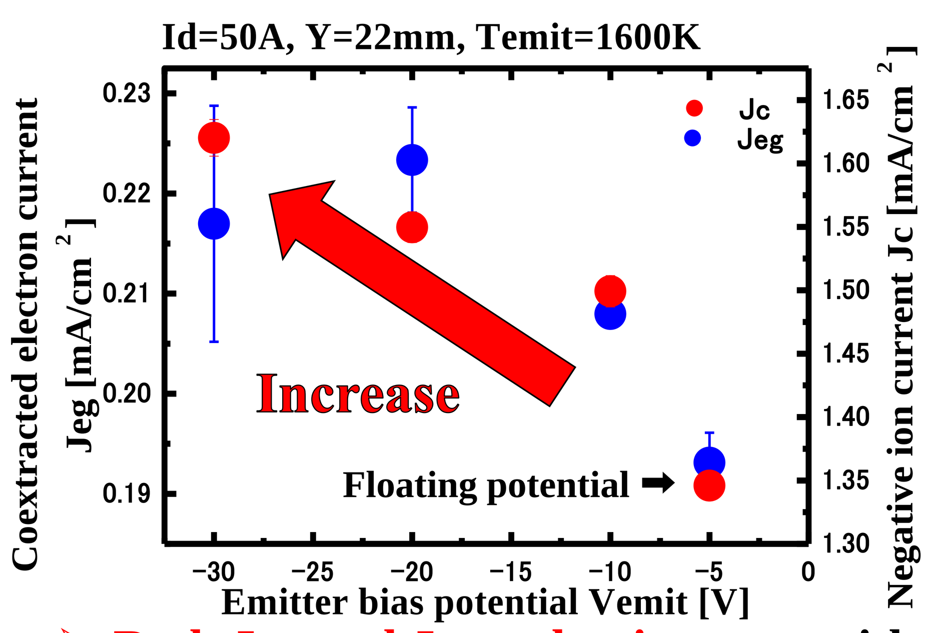
- W filament is installed at a position of 25 mm from the center of the plasma.
- Supply cold electrons by thermionic emission.

Effect of New Electron Emitter



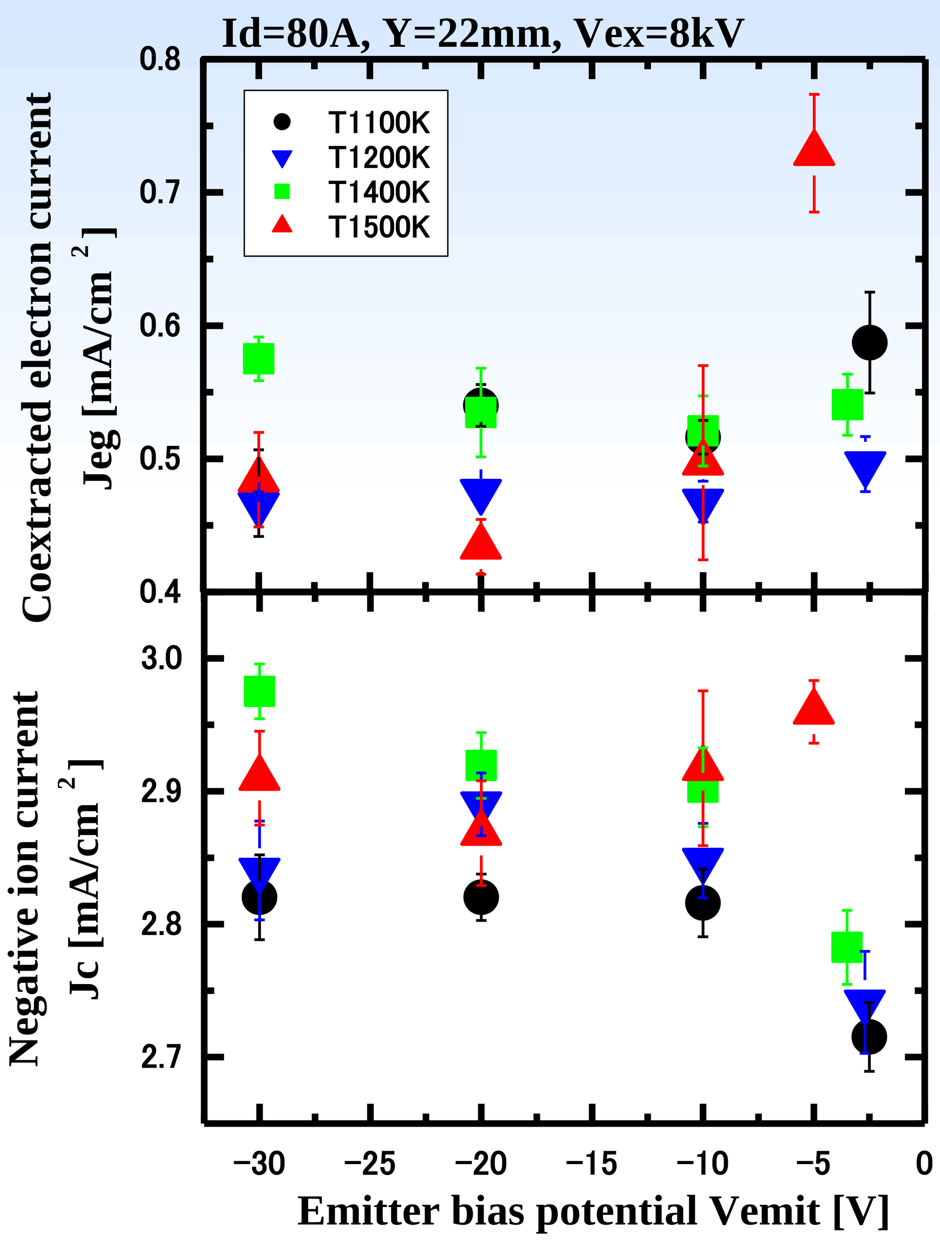
Negative ion current density versus distance from plasma center with 0.2mm SMF and 0.5mm spacer

- Jc tends to increase as the temperature of the electron emitter rises (average 30% increase from 1100K to 1700K)



Coextracted electron current density versus emitter bias potential with 0.2mm SMF and 0.5mm spacer

- Both Jeg and Jc tend to increase with the application of negative bias to the emitter (Jc:Max 20% UP)



Coextracted electron current density versus emitter bias potencial (up) and negative ion current density versus emitter bias potencial with 0.2mm SMF and 0.5mm spacer

- At Id=80A, Jeg is reduced by negative bias
- Increase in Jc due to negative bias has a smaller effect as Temit increases

Summary

Extracted current density was successfully increased by using electron emitters.

- Extracted current density increased (average increase of 30%) due to low-energy electrons supplied to the plasma peripheral region
- Applying a negative bias to the emitter increases Jc by max 20%.

From the above, it was found that electron emitters are effective in promoting negative ion production. In the future, we plan to investigate the relationship between the emitter potential and space potential, and the formation of vibrationally excited molecules.

Reference

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Aknowledgement

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