**Comments from a Reviewer to Authors**

**Article submitted to *AIP Conference Proceedings***

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| Manuscript ID: | #24 |
| Title: | Analysis of plasma characteristics of high-power radio frequency negative ion source based on Langmuir probe |
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| Manuscript type: | Proceedings article |

The authors reported the experimental results measured with planar and cylindrical Langmuir probes in RF plasmas at ASIPP. With use of these probes, which were made by the authors, plasma parameters such as electron density, electron temperature and Electron Energy Probability Function (EEPF) were measured by changing the position of the probe tips. Comparing the density of electrons with the line averaged electron density obtained with microwave interferometer, validity of the probe result was tested. This manuscript is well structured, and English is average. The figures are goodly drawn, and tables are well organized. The number of the references is enough and appropriate.

In the section of “Experiment and Result”, the definition of the origin was not clear. For instance, the origin in Fig. 5 (c) and 6 (a) in the x direction are different. It brings a confusion to the readers. Furthermore, although the correspondence of the data between planar and cylindrical probes are expected, the filling gases were Ar and H2 in the figures of 5 and 6, respectively. In this case, direct comparison is very difficult. The other comments and questions are shown in the following list.

For the reason above, I select “minor revision” to the authors and I would like to request the authors of this article to describe something new experimental results.

Reply:

Reply:

Thanks for the reviewer’s comment.

The results shown in Fig. 5 and Fig. 6 are obtained under different test platforms. and the coordinate systems used are different. The Fig. 5 is the result of the probe test platform (Fig. 1 and Fig. 2). The Fig. 6 is the result of the RF negative ion source (Fig. 3 and Fig. 4(b)). The filling gas is argon (Ar) in the probe test platform (Fig. 5). There are many kinds of ions (H-, H+, H2+, H3+) in the hydrogen discharge process. But only argon ions and electrons exist in the argon discharge process, it is helpful to verify the effectiveness of the probe. The filling gas is hydrogen molecular (H2) in the RF negative ion source (Fig. 6).

The other responses are shown in the following list.

[*List of Questions and Comments*]

1. [INTERDUCTION, the 3rd line in the 1st paragraph, page 2]: The authors wrote that “So, a self-made planar probe …” seems to be” So that a self-made planar probe …” or “Therefore, a self-made planar probe …”.

Reply:

Thanks for your suggestion.

“So, a self-made planar probe …” is revised to “Therefore, a self-made planar probe …”.

1. [EXPERIMENT AND RESULT, the 3rd line in the 1st paragraph, page 4]: “… of RF power, but …” could be “… of RF power, while …”.

Reply:

Thanks for your suggestion.

“… of RF power, but …” is revised to “… of RF power, while …”.

1. [EXPERIMENT AND RESULT, the 3rd line in the 1st paragraph, page 4]: “… of RF power, but the plasma density…” could be “… of RF power, while the electron density”, because the authors compared electron density obtained with microwave inter ferrometer and Langmuir probe.

Reply:

Thanks for the reviewer’s comment.

“… of RF power, but the plasma density…” is revised to “… of RF power, while the plasma density…”.

1. [EXPERIMENT AND RESULT, the 8th – 9th lines in the 1st paragraph, page 5]: The authors wrote that “and the electron temperature decreases from 8.1 eV to 5.9 eV.” by increasing the RF power. Why?

Reply: Thanks for pointing out the imprecise description.

“and the electron temperature decreases from 8.1 eV to 5.9 eV.” is revised to “The electron temperature (Te) gradually decreases in the power range of 200 W to 300 W, Te remains nearly constant in the power range of 300W to 500W. In our experiment, we found that in the range of lower power (<300W), the plasma is unstable, which results in a large fluctuation of Te (see the error bar in the Fig.5(b)), when the RF power is greater than 300 W, the plasma tends to be stable and the fluctuation of Te reduce to a relatively small range and nearly keep unchanged. A possible reason is that during the diffusion of the high energy electrons, it will transfer their energy to the background particles through continuous collisions, as the route is long enough to exhaust the energy of high energy electrons, as a result, Te is almost keep a constant with the increase of RF power (the plasma reaches a steady state )”. The result is similar to the simulation result in Reference 9.

1. It is not clear that where the origin of probe measurement. Indeed, electron density in Fig. 5(c) increases with moving the probe tip toward larger x values, while the density has a peak near x of origin. Which coordinate is correct?

Reply:

The results shown in Fig. 5 and Fig. 6 are obtained under different test platforms. The Fig. 5 is the result of the probe test platform, and the probe test platform is shown in Fig. 2. The Fig. 6 is the result of the RF negative ion source, and the RF negative ion source is shown in Fig. 3 and Fig. 4(b).

1. The coordinate is indicated with a set of (x, y, z) in Fig. 3. On the other hand, it is defined as a set of (X, Y, Z) in Fig. 4(b), Fig. 5 and Fig. 6 as well as the main text. It is recommended to unify the notation.

Reply:

Thanks for your suggestion.

The axial coordinate of the probe test platform is indicated with x in Fig. 2 and Fig. 5. The coordinate of the RF negative ion source is indicated with a set of (X, Y, Z) in Fig. 3 Fig. 4(b) and Fig. 6.

1. In Fig. 6, parentheses of Fig. 6(d) and 6(e) are lacked in corresponding graphs.

Reply: Thanks for your suggestion.

The parentheses of Fig. 6(d) and 6(e) in corresponding graphs are added, as shown below.



1. Compared with Fig. 5(d) and Fig.6(e), the characteristics are different. Is this caused by the difference of the filling gases?

Reply:

Firstly, Fig. 5 and Fig. 6 are measured on different experimental setup, Secondly, Fig. 5 is measured without magnetic field. Figure 6 is measured under the filtered magnetic field, So the electron temperature is mainly concentrated in 1-2eV.

1. The coordinate of the line-of-sight of microwave interferometer is not shown except for Fig. 5(a). In addition, it is not clear whether the line-of-sight is parallel to the x, y or z axis.

Reply:

Thanks for the reviewer’s comment.

The line-of-sight of microwave interferometer is shown in Fig. 2. the line-of-sight is perpendicular to the x axis.

1. Is the direction of the coordinate axis true as indicated with the arrow set at the right upper corner in Fig. 4(b)?

Reply:

The coordinate axis in Figure 4 has been rebuilt. The direction of the coordinate axis is true as indicated with the arrow set at the right upper corner in Fig. 4(b).

1. The filling gases are indicated as argon (Ar) and hydrogen molecular (H2) in Fig. 5 and Fig. 6, respectively. Did the authors change the gas to obtain the data illustrated in those figures?

Reply:

The filling gas is argon (Ar) in the probe test platform (Fig. 5). Because there are many kinds of ions (H-, H+, H2+, H3+) in the hydrogen discharge process, however only argon ions and electrons exist in the argon discharge process, it is helpful to verify the effectiveness of the probe. The filling gas is hydrogen molecular (H2) in the RF negative ion source (Fig. 6).

1. All the measured coordinate should be indicated in all the figures or figure captions as well as the main text.

Reply:

Thanks for your suggestion.

All the measured coordinate has been indicated in all the figures.

1. The authors applied both of planar and cylindrical probes in this experiment. However, it is not clear which probe was utilized in each figures. It is necessary to indicate which probe was applied for each measurement.

Reply:

Thanks for your suggestion.

The type of probe used in each figure captions are given.

1. Is it available to compare and to obtain the correlation between the plasma parameters measured with planar and cylindrical probes?

Reply:

As the installation positions of planar probes and cylindrical probes are different, it is unavailable to compare and to obtain the correlation between the plasma parameters measured with planar and cylindrical probes. However, it can be inferred that the measurement results of the cylindrical probe and the planar probe are similar from Fig. 6(a) and Fig 6(b).

1. [EXPERIMENT AND RESULT, the 6th lines in the 2nd paragraph, page 6]: “in vertical direction” is not clearly defined the “vertical” to which direction. It’s better to change to “in vertical direction, z direction,” or “in vertical direction (z direction)”

Reply:

Thanks for your suggestion.

“in the vertical direction of expansion chamber” is revised to “in the vertical direction of expansion chamber (z direction)”.