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# セシウム添加負イオン源内の水素とヘリウムプラズマ特性の比較
# Comparison of hydrogen and helium plasma characteristics in a caesium-seeded negative ion source

津守克嘉[1,2]、和田　元[3]、木﨑雅志[1,2]、池田勝則[1]、中野治久[1,2]、波場泰昭[4]、永岡賢一[1,4]、藤原　大[1]、神尾修治[1]、正木伸吾[2]、長壁正樹[1,2]
K. Tsumori[1,2], M. Wada[3], M. Kisaki[1,2], K. Ikeda[1], H. Nakano[1,2], Y. Haba[4], K. Nagaoka[1,4], Y. Fujiwara[1], S. Kamio[1], S. Masaki[2], and M. Osakabe[1,2].

[1]核融合科学研究所、[2]総研大、[3]同志社大学、[4]名古屋大学
[1]NIFS, [2]SOKENDAI, [3]Doshisha Univ, [4]Nagoya Univ.

Deuterium beam injection is essential for reactor-oriented plasma experiment in the fusion research. Plasma experiments using deuterium plasma with deuterium beam injection have been and will be carried out in most of the recent fusion machines. In the Large Helical Device (LHD), deuterium plasma experiment has started since 2017 and deuterium beam injection have started with three negative-ion based NBI beamlines and two positive-ion-based ones. Comparing to the acceleration of hydrogen negative ions ($H^-$ ions), the current density of deuterium negative ions ($D^-$ ions) decreased down to 50 – 70 %, co-extracted electrons increased and the caesium (Cs) consumption increased in an optimized case for $D^-$ ion beam. It is expected that deuterium ions and atoms in ion-source plasma carries larger momentum to adsorbed Cs atoms on the wall and enhance to evaporate the Cs.

To investigate the influence of the mass difference of plasma particles, Cs vapor pressure was measured in hydrogen and helium plasmas. Although comparison using hydrogen and deuterium plasmas was direct, it was forbidden to utilize deuterium gas in NIFS NBI test-stand. As an alternative gas, helium was utilized in this experiment.

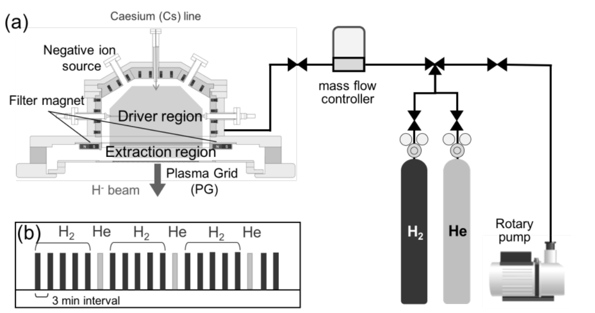


Figure 1. (a) experimental setup and (b) discharge cycle using helium and hydrogen plasmas.

The experimental setup is shown in Fig. 1(a). hydrogen and helium gases are changed via a three-way valve and residual gas was pumped before the gas change. The discharge cycle of operational gases is shown in Fig. 1(b). To avoid the degradation of the discharge, five hydrogen discharge were performed after a helium discharge to avoid the gradual increase the discharge resistance due to helium plasma.

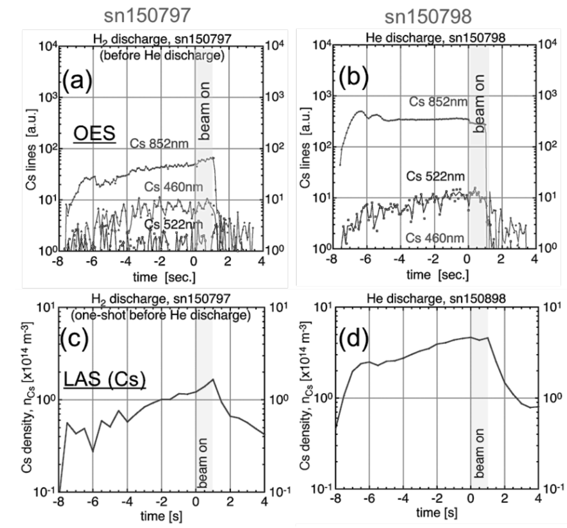


Fig. 2. Waveforms of OES signals of the plasmas (a) hydrogen and (b) helium in a negative ion source, and those of Cs densities obtained with Cs laser absorption spectroscopy in (c) hydrogen and (d) helium plasmas.

In upper graphs of Fig. 2, waveforms of Cs lines obtained with optical emission spectroscopy (OES) in the (a) hydrogen and (b) helium plasmas is indicated. It is clearly shown that the signal of Cs 852 nm (Cs 0) is about one-order higher of the magnitude in the helium discharge. In the case of OES, the line intensities are influenced with electron density and temperature. To separate the influences, Cs laser absorption spectroscopy (LAS) was applied to measure the difference of the Cs atomic densities as shown in Fig. 1 (c), hydrogen discharge, and (d), helium one. By taken into account of the plasma density and energy of positive ions, it becomes clear that the mass of the positive ions enhances the evaporation of Cs atoms from the wall.

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