§2. Optical Observation of Cesium Spectra in a Hydrogen Negative Ion Source at 20 Seconds Beam Operation

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Hydrogen negative ion (H^-) source is an indispensable instrument for high power and high-energy neutral beam injector (NBI). Cesium (Cs) vapor is supplied from three Cs ovens equipped on the back plate of the NIFS negative ion source to improve the H^- production as shown in Fig, 1. It is more better that many H^- ions are produced with little Cs. To investigate the Cs distribution in the negative ion source, we have arranged several optical sight lines at the discharge area and at the magnetic filter area near the plasma grid. According to the probe measurement in an 80kW arc power discharge, the electron density and electron temperature is n_e=3x10^{18}/m^3 and Te=5eV at discharge area, respectively.[1,2] In the magnetic filter area, the electron density and the electron temperature hold down to n_e=0.5x10^{18}/m^3 and Te=2eV by the filter field, respectively.

Figure 2 and 3 shows the time evolution of the Cs^+ ion and Cs^0 neutral spectrum normalized Hγ light emission in the 20 sec beam operation with 78kW arc discharge power. In this discharge, the acceleration drain current is 16.5A almost constant. The intensity of the Hγ light emission is also constant during discharge, so the electron temperature and density are presumed constant condition during beam extraction. At the beginning of the beam extraction, Cs^+ ion light emission step up to the higher level, and it intensity increases continuously during beam extraction at discharge area as shown in Fig. 2. Sputtering Cs from the back plate of the arc chamber surface due to the impact of the back streaming H^+ ion with acceleration potential causes increasing Cs^+ ions in the discharge area. We also observe the same Cs^+ increasing near the PG area, but it signal is small. On the other hand, Cs^0 neutral signal is not so increases in the discharge region as shown circle marks in Fig, 3. It indicates sputtering Cs from the back wall of the arc chamber is almost ionized. Cs ions from the back plate invade from the PG area, but Cs ions do not contaminate the extraction area due to the extraction potential.

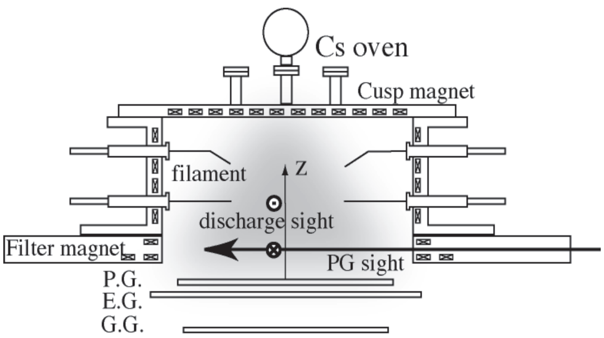

Fig. 1. Cross-section view of the negative ion source with the optical configurations.

We have observed intense Cs^0 light emission at the PG area where is the low electron temperature region. Only the Cs^0 light emission increases rapidly at the PG area after the 13 seconds beam extraction. It is thought that the neutral Cs particles evaporate around PG area other than the back plate. From the estimation of the Cs particle fraction used the probe result, neutral Cs at PG area is 100 times larger than neutral Cs at discharge area. Neutral Cs with thermal energy is likely to contaminate the extraction area, but this is not large amount. The neutral Cs around the PG area estimated from the optical emission intensity is ten times smaller than Cs ions at the discharged area.

1) K. Ikeda, U. Fantz, et al., : Plasma and Fusion Research, 2, S1047 1-4(2007)
2) K.Ikeda, K.Nagaoka,et al., : Review of Scientific Instruments、79、(2)、A518 1-4、(2008)

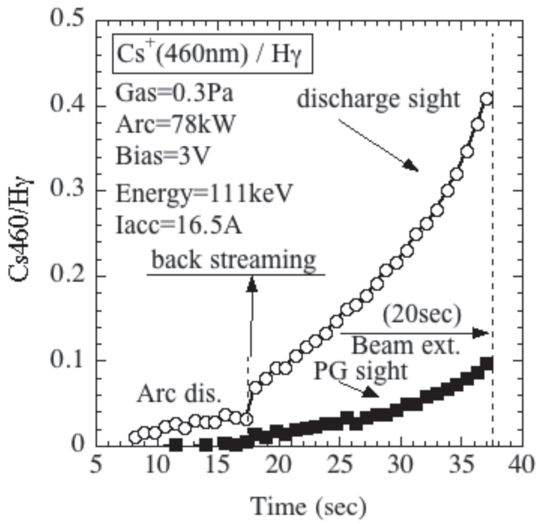

Fig. 2. Time evolution of the spectrum intensities from neutral Cs normalized by Hγ light emission.

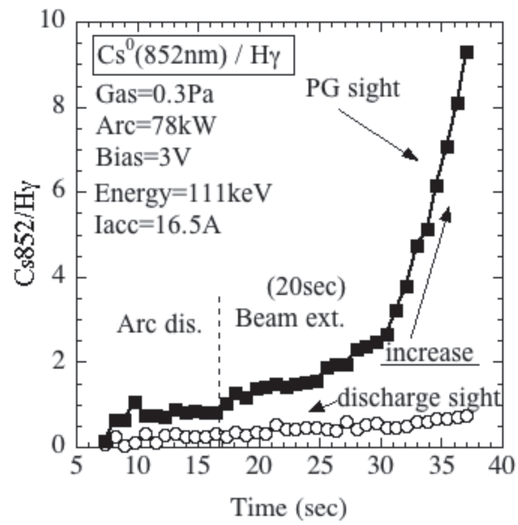

Fig. 3. Time evolution of the spectrum intensities from neutral Cs normalized by Hγ light emission.