§5. Simultaneous Extraction of H^- and Li^- from a Li Vapor Injected Hydrogen Discharge

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As the number of ports of plasma confinement devices available for diagnostics purposes, an approach to utilize the beam line of a neutral beam injection(NBI) heating for launching a diagnostic beam becomes more attractive. When the negative ions of a hydrogen isotope are used for the neutral beam heating, adding Li vapor into the discharge should deliver Li^- ions that can be possibly used for the diagnostics of magnetic field, electron density, and fusion produced alphas.[1] However, addition of Li vapor into a high density hydrogen discharge in an ion source may hinder a reliable operation of the entire NBI system and the research to reveal possible problems associated with Li vapor injection into a negative hydrogen (H^-) ion source has been initiated.

A preliminary test has been done with a compact Li^- ion source.[3] The size of the ion source is 6 cm in diameter and 6 cm in length. It was originally designed to be operated with a heat shield. The presence of a heat shield had a little effect on the amount of negative ion current extracted from the ion source loaded with pure hydrogen gas. Meanwhile, the heat shield insertion had decreased the amount of drain electron current by a factor of two. In the present ion extraction geometry, the heat shield seems to yield an effect similar to that by the collar.[2]

However, the amount of Li vapor drains out of the ion source seems increased by the equipment of the heat shield. Without the heat shield, the Li injected from the oven condenses on the cold wall of the ion source, and never gets back into the discharge. The rapid pumping of Li can be confirmed by running a discharge without hydrogen gas. If the source is operated with Li vapor only, depletion of Li results in insufficient ionization in the ion souce, and thus, a cessation of a discharge. The time it took from the termination of the oven heating power to the end of the discharge was about 2 minutes when the heat shield was equipped, while it was more than 3 minutes when the heat shield was removed.

Figure 1 shows typical variations of negative ion currents and the extraction current, which is mainly the electron current extracted from the ion source. As shown in the figure, the amount of H^- current does not change much by the injection of Li into the ion source. The Li^- current increases as Li vapor is introduced. The extraction current increases by the Li injection, corresponding with the increase in electron density near the extraction region. Though the H^- current usually increases by the addition of Cs vapor into a hydrogen discharge, Li vapor injection showed little effect on the enhancement of H^-.

In summary, Li vapor injection into a H^- source seems to realize the Li^- beam production usable for the plasma diagnostics. The contamination of the ion source due to Li injection can be minimized by properly arranging the Li flow so as to condense Li at a specified region of the ion source wall. No adverse effect on the ion source operation by Li injection other than fractional increase in extraction current has been observed. Yet, experiments with higher electron density, cesiated hydrogen discharge and large area extraction are necessary to warrant a reliable operation of the heating/diagnostic beam system. Further research is still being made.

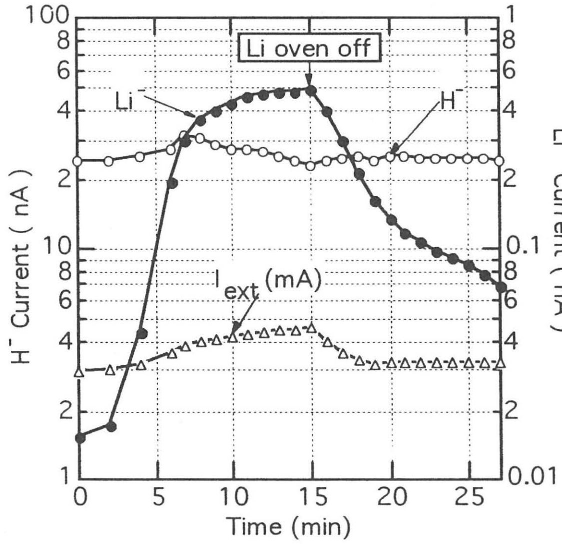

Fig. 1 Negative ion currents of Li and hydrogen plotted as functions of time after turning on the heating power of the Li oven. The extraction current, I_{ext}, is also plotted in the figure.

References
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