Contribution ID: **284** Type: **Poster**

Application of laser-induced breakdown spectroscopy (LIBS) for in situ characterization of lithium deposition layer on EAST tokamak

Tuesday 6 June 2017 13:40 (2 hours)

Lithium wall conditioning has been a routine method to reduce fuel recycling and impurity deposition, which significantly improves the plasma performance in EAST tokamak [1]. In the 2016 EAST experimental campaign, with the help of intensive lithium wall conditioning, one-minute steady state long-pulse H-mode discharge was obtained. However, the time and amount of lithium used for the daily wall conditioning were from previous experience. There are no effective methods for in situ and real time characterizing of wall conditioning situation on the first wall, especially the thickness and the local growth rate of deposited lithium layer as well as the hydrogen isotopes retention in the lithium layer. Laser-induced breakdown spectroscopy (LIBS) is a promising candidate for in situ characterization of the first wall. Recently, an in situ and remote LIBS system has been established for the first wall condition monitoring in the EAST tokamak [2].

In this work, the growth rate of the lithium layer was in situ and real time monitored by LIBS during the lithium wall conditioning. The results showed that the growth rate of the lithium layer was fast at the beginning of lithium conditioning and the growth rate becomes slower with time. According to post LIBS analysis in the laboratory, about 100 nm deposition layer ablated by one laser shot at the same energy density. About 2 um lithium layer was estimated deposited on the first wall by lithium wall conditioning by 200 minutes in EAST. The thickness of the coating layer showed consistency with the amount of lithium for wall conditioning. The thicknesses of lithium coating layers were measured after wall conditioning and after a whole day plasma discharge for comparison. The results showed that about 500 nm lithium deposited layer was removed by EAST plasma discharges per day. The hydrogen isotopes were measured as well. The H/(H+D) ratio in the deposited layer after lithium conditioning was lower than that after EAST discharge, which means the deuterium was saturated with the reducing of the deposited layer and D-D discharge. The investigation of lithium layer and the hydrogen isotopes by LIBS in EAST will help to optimize and predict the wall conditioning for EAST operation and demonstrate the potential using LIBS in ITER.

[1] Wan B., J. Li, H. Guo, et al., Nucl Fusion, 2015. 55(10):104015.

[2] Hu Z, Li C, Xiao Q, et al., Plasma Sci. Technol.,2017. 19(2): 025502.

Eligible for student paper award?

No

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Session Classification: T.POS: Poster Session T

Track Classification: Plasma-material interactions, plasma edge physics