# In-situ wall diagnostic studies of co-deposition of fuel, impurities and lithium using laser induced breakdown spectroscopy in EAST

Cong Li[a*], Zhenhua Hu[b], Qingmei Xiao[a], Ran Hai[a], Dongye Zhao[a], Xingwei Wu[a], Jing Wu[b], Guang-Nan Luo[b], Jiansheng Hu[b], Hongbin Ding[a**]

[a]*Key Laboratory of Materials Modification by Laser, Ion and Electron Beams, Chinese Ministry of Education, School of Physics and Optical Electronic Technology, Dalian University of Technology, Dalian, 116024, P. R. China*

[b]*Institute of Plasma Physics, Chinese Academy of Sciences, PO. Box 1126, Hefei, 230031, P. R. China*

[*]Presenting author: cli@mail.dlut.edu.cn

[**]Corresponding author: hding@dlut.edu.cn

Lithium (Li) can significantly enhance plasma performance by reducing hydrogen isotopes content and impurity recycling in nuclear fusion devices. With Li wall conditioning, H-mode with a pulse duration over 30 s has been achieved in Experimental Advanced Superconducting Tokamak (EAST) [1]. However, the details of the mechanisms of lithiation, specifically the co-deposition processes of fuel, impurities and Li still remain unclear due to the lack of a suitable means of assessing plasma-wall interactions in-situ. Laser induced breakdown spectroscopy (LIBS) is a useful tool for qualitative and quantitative analyses of the first wall in nuclear fusion devices. In this work, a LIBS system was developed presently and applied in-situ to measure and monitor the composition evolution on the plasma facing materials (PFMs) at the high field side of EAST. LIBS signal provided the fuel, impurities and lithium erosion/deposition distribution in real time, which was in consistent with the wall conditioning processes. The wavelength coverage of LIBS signals of Li, deuterium (D) and impurities in co-deposition was recorded from 200 to 980 nm before and after the wall processing procedures and discharges. Several known analytical spectral lines of H, W, C, O, Ti, Si, Fe, Cr, Ni, Mn, Mo, Cu and Al can be detected and identified. The depth profiles of D, impurities and Li from co-deposition layers of up to 500 μm were studied by using successive number of LIBS laser shots. The intensity variation of spectral lines with successive number of laser shots has been studied to evaluate the co-deposited layer thickness, composition and impurity profiles as a function of depth. The depth resolution was about 50-200 nm for the different materials using a Nd: YAG laser (5ns, 1064 nm) with maximum energy density of 25 J/cm$^2$ (5 GW/cm$^2$). There were the significant mixture-depositions from impurities (C, O, Si, W, Mo, Fe and Ni) with Li and moderate co-deposition between H/D and Li. Moreover, LIBS technique has been tested for real-time removal of the co-deposited layer of the same tile, and it is proved to be a useful technique for cleaning the contaminated first mirrors. The LIBS system will be a unique and useful diagnostic for the wall in 2014 EAST campaigns. This work would improve the understanding of mechanism by which Li enhances plasma performance and give guidance to optimize the wall conditioning in EAST.

[1] J.Li, H.Y.Guo, B.N.Wan, et al, Nature Physics, 9 (2013) 817-821

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