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Preliminary Design of Laser-Induced Breakdown Spectroscopy Diagnostic for Divertor Analysis in EAST

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Preliminary Design of Laser-Induced Breakdown Spectroscopy Diagnostic for Divertor Analysis in EAST

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Analysis and understanding of plasma wall interaction which results in deposition, erosion, and fuel retention on the plasma facing materials (PFMs) is among the most important task for magnetic confinement nuclear fusion devices. Laser-Induced Breakdown Spectroscopy (LIBS) is a well-established elemental composition analysis method as well as one of the most promising method for the wall diagnosis of fusion devices in situ [1]. A LIBS system has been developed and applied in situ to measure and monitor the composition evolution on the PFMs at the high field side of superconducting and long-pulsed EAST tokamak starting from the 2014 campaign. LIBS signal provided the fuel, impurities and lithium erosion/deposition distribution in real time between main plasma discharges and during wall conditioning processes [2]. The result shows that H, D, Li, Mo, C, W, Si, et al. elements lines can be identified from the LIBS spectra. The lithium-deuterium and -hydrogen co-deposition layers with thickness between few hundreds of nanometres and few micrometres can be found on the first wall of deposition area. The H/(D+H) ratio on the first wall was obtained between 20%-30% which is much higher than in the main plasma. In this work, a conceptual study for an upgraded LIBS system at the "H port"of EAST tokamak will be presented. The detected area of the system will cover the divertor region of EAST. The LIBS spatial resolution on the divertor tile surface is able to reach to 0.2 mm to present 2D mappings of each element in both erosion and deposition areas by using a series of motorized optical component integrated in an endoscope device. The spectral wavelength range of 200-900 nm with resolution of 0.1 nm and maximum laser energy of 330 mJ@1064 nm with 5 ns pulse width can be achieved by using a multichannel spectrometer and a Nd:YAG laser, respectively. An ICCD detector and a ps pulsed laser system will be installed in future to further improve the spectral sensitive and ablation depth resolution on materials. This work can be valuable for the understanding of plasma wall interaction about divertor physics in long-pulsed fusion device.
[1] V. Philipps, et al., Nucl. Fusion 53, 093002 (2013)
[2] C. Li, et al., J. Nucl. Mater. 463, 915–918 (2015)
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Eligible for student paper award?

No

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