

P4.3007 Picosecond laser-induced ablation techniques for depth-resolved quantitative analysis of plasma-facing components

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See full abstract here:

<http://ocs.ciemat.es/EPS2019ABS/pdf/P4.3007.pdf>

Monitoring the fuel content in plasma-facing components is essential to get a detailed understanding of the plasma-wall interaction. Laser-induced material analysis is frequently used in fusion devices [1, 2], but there is a lack of diagnostics which can provide depth resolved and quantitative information when no reference sample can be manufactured. We present a post mortem analysis using laser-induced breakdown spectroscopy (LIBS) combined with quantitative residual gas analysis (RGA) after picosecond laser ablation for this challenge.

Using a laser spot diameter of 700 μm on the sample and an intensity of $\sim 150 \text{ GW/cm}^2$, typical material ablation rates are $\sim 100 \text{ nm}$ per laser pulse for graphite and $\sim 30 \text{ nm}$ per pulse for tungsten. With short pulse durations of the laser ($\tau = 35 \text{ ps}$) and a wavelength of $\lambda = 355 \text{ nm}$, the ablation rates are in the same order of magnitude as heat and optical penetration depth of the laser. Thus, sequential ablation steps offer a depth-resolved analysis of the material composition using picosecond laser-induced breakdown spectroscopy (ps-LIBS). Volatile components are detected by a calibrated quadrupole mass spectrometer, providing quantitative concentrations without the need for reference samples. The simultaneously operated techniques are applied for post mortem analysis of plasma-wall interaction processes like erosion, deposition and fuel retention of Wendelstein 7-X graphite tiles [3]. In this work we focus on the application for retention measurements of deuterium in tungsten as preparation of a potential in situ application in fusion devices. Particle densities as low as 1×10^{20} deuterium atoms per cm^3 could be quantified.

References

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- [2] C. Li, CL. Feng, H.Y. Oderji, et al., Frontiers of Physics 11, 114214 (2016).
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