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Quantification of eroded Fe contamination in plasma activated water using Surface Assisted LIBS

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Cold plasma discharges generate reactive oxygen and nitrogen species (RONS), which can be trapped in the liquid phase to form plasma-activated water (PAW), a chemically rich solution with applications in agriculture, biomedicine, and environmental treatment. When transient spark (TS) discharges are coupled with electrospray (ES) microdroplet generation, PAW production efficiency increases significantly due to the enhanced plasma–liquid interaction area. However, this configuration also leads to electrode degradation and the release of metallic ions and nanoparticles, which can alter PAW chemistry through catalytic or Fenton-type reactions [1, 2].
In this work, we employ surface assisted laser induced breakdown spectroscopy (SA LIBS) [3,4] to detect and quantify the eroded metallic species in PAW produced by the TS–ES system [5]. The PAW samples were dried on polished silicon wafers to form a thin film, providing a stable surface for ablation and minimizing splashing and plasma quenching associated with direct liquid analysis. A tuneable OPO laser (EKSPLA NT342C, 532 nm) was focused onto the dried films to generate laser-induced plasma, and the resulting emission spectra were recorded using an echelle spectrometer (ME5000, Andor) equipped with an iCCD detector (iStar DH743, temporal resolution 5 ns). The quantification was done using Calibration-Free LIBS at different gate timings under air at atmospheric pressure [6].
The SA LIBS approach enabled sensitive detection of metallic contaminants in PAW with improved signal stability and reproducibility compared to direct liquid LIBS. This method demonstrates the potential of SA LIBS for monitoring electrode degradation and metal transport in plasma–liquid systems, offering a simple and efficient route for chemical characterization of PAW.
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