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Femtosecond laser-induced breakdown spectroscopy of desorbed neutral surface contaminants from rapidly heated wires

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Sandia National Laboratory's Z Pulsed Power Facility provides a 20-MA, 100-ns current pulse to various cm-scale targets like the magnetized liner inertial fusion (MagLIF) concept. A next generation pulsed power facility is being considered that would be able to deliver more current than the Z facility can today. However, it has been observed on the Z facility that current loss occurs in the magnetically insulated transmission lines (MITLs) as they heat up, desorb neutral surface contaminants, like water, on the order of 10^{15} cm^{-3}, and form plasmas that can shunt current across anode-cathode (AK) gaps. Since desorption effects are non-linear, it is important to desorption for accurate modeling of future MITL designs. Measuring neutral desorption has proven challenging as it requires nanosecond quantification of 10^{15} cm^{-3} gases.

We report on our first efforts to measure desorbed gases from SAE 304 stainless steel wires heated by an 80-kA, 400-ns wire pulser using femtosecond laser-induced breakdown spectroscopy (fs-LIBS). This novel approach, which has previously been shown to exhibit a detection floor on the order of 1014 cm-3 in relevant gases on relevant timescales, forms a localized plasma from the desorbed neutral contaminants. We employ stainless steel wires with thicknesses on the order of the electrical skin depth (~500 μm) to confine the current density to provide comparable heating rates to the Z facility and its potential successors.

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