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Depth-resolved analysis of technologically relevant materials by simultaneous LA-ICP-MS & LIBS measurements

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To meet the challenges of the 21st century, like global warming and increasing energy consumption, tremendous progress in material science has been essential for the last decade. To optimize technology relevant for energy production and storage (e.g., solar cells, fuel cells, and batteries) and systems exposed to high temperatures, corrosive milieus, or mechanical impact (e.g., machining, aerospace industry), novel high-performance materials are inevitable. To establish a correlation between composition and function, a fast analytical characterization is necessary since crucial material properties are determined by the elemental composition from the bulk stoichiometry down to dopants present with lower contens or unwanted impurities.

For the spatially resolved characterization of high-performing materials, direct solid sampling methods like LA-ICP-MSor LIBS can be used as analytical techniques. While LA-ICP-MS is more suited for the analysis of trace elements, LIBS offers the possibility to analyze elements like O, H and N, which are not accessible for LA-ICP-MS.

In this work, a method for simultaneous LA-ICP-MS & LIBS measurements is presented. To demonstrate the capabilities of this setup, a depth-resolved analysis of the challenging element oxygen in ceramic and coating materials has been performed. LIBS with ICCD detection provided sufficient sensitivity for oxygen analysis, while all other sample constituents were measured using ICP-MS, enabling accurate determination of changes in sample composition. The application of a 193 nm excimer laser system enabled fast measurements with a depth resolution in the order of 100 nm only, showing the potential of this method to provide depth-resolved information about overall differences in stoichiometry and oxidation behaviors.

LA-ICP-MS, LIBS, depth profile analysis, oxygen-distribution