

Exploring factors conditioning laser-induced acoustics and its potential as a LIBS-hyphenated technique

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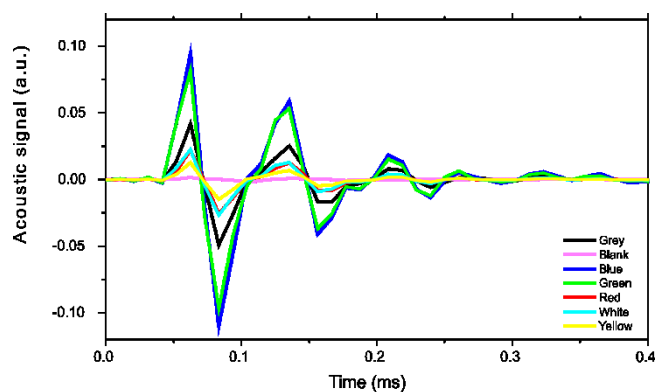
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Despite the interest shown previously in employing the laser-induced acoustic shockwave generated alongside the plasma as a mean to expand the information delivered by LIBS inspection of solids¹, the multiple sources of uncertainty linked to sound waves have hindered their potential application in in-lab and off-lab sensors. Still, the recent integration of a microphone synchronized to the LIBS laser in the Perseverance rover deployed as part of the NASA mission Mars 2020 has re-kindled the motivation towards comprehending the different phenomena taking place during the lifetime of the shockwave in order to extract from it the contribution of the inspected sample.

In this work, sets of morphologically-controlled samples coming from chemically identical materials are probed under similar experimental conditions to systematically test the impact of sample-related traits as well as environmentally-induced factors upon the collected audio signal. Geometrical factors such as diameter and thickness as well as sampling position are explored using

aluminum samples. Sample absorption of the impinging laser light was also tested in Al and plastic samples as it conditions the laser-sample coupling characteristics of the produced plasma. These studies verified the relationship between the sample's extinction coefficient and the total acoustic response. Moreover, 3D-printed probes were used to evaluate how material porosity modified the resulting acoustics.

Environmental effects were taken into account. The use of diverse flooring in the sample-microphone path revealed changes in the acoustic spectra after the first positive maximum, indicating the formation of terrain-dependent interference patterns. Lastly, we observed that parameters such as height of the microphone or the microphone-to-sample distance play a key role in acoustic experiments. Based on these results, final experimental conditions should be well-defined and chosen in order to avoid non-chemical environmental and sample contributions altering laser-induced acoustics.



Influence of the absorption coefficient on the acoustic signals

[1] Santiago Palanco and Javier Laserna, "Spectral analysis of the acoustic emission of laser-produced plasmas," *Appl. Opt.* 42, 6078-6084 (2003). DOI: 10.1364/AO.42.006078