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Reflection and Backscattering of IR Radiation from Free Space Laser Plasmas in Air¹

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ABSTRACT

Femtosecond generated laser filaments experience efficient propagation of optical energy across long distances and the controllable generation of laser plasmas at range, such as with Laser Induced Breakdown Spectroscopy (LIBS) for the analysis of solids and backwards lasing for detection of trace species in gases. However, the detection of remote spectroscopic signatures is often limited by the low concentration of trace species, the low density of gas phase measurements, and the reduction in signal strength with standoff distance with the inverse square law for isotropically emitting signals. In this work, we propose utilizing free space laser plasmas, capable of partial reflection and scattering of incident light, to improve the signal collection of remote isotropically emitting signals. Here, we study the properties of a probe signal reflected from a single laser generated plasmas in air utilizing a pump-probe scheme, which exhibits large shot-to-shot variation and transient behavior. Nanosecond and femtosecond laser generated plasmas are probed by a low energy nanosecond Optical Parametric Oscillator (OPO) laser capable of continuously variable emission in the 1.1-4.4 μm band. The transmissivity and reflectivity are measured and reported as functions of incident wavelength, pump-probe delay, and probe position along the pump beam's optic axis. Implications to optical sensing technologies are discussed.

Keywords: Laser plasma, ultrafast laser, reflection, remote sensing, pump-probe

REFERENCES

- [1] Meehan, K. C., Zhang, B., Chirinos, J., Mao, X., and Zorba, V., "Reflection and backscattering of IR light from free space laser plasmas in air," in [*Real-time Measurements, Rogue Phenomena, and Single-Shot Applications X*], Solli, D. R., Herink, G., and Bielawski, S., eds., **PC13348**, PC133480E, International Society for Optics and Photonics, SPIE (2025). DOI: <https://doi.org/10.1117/12.3043537>.

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