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Free Space Laser Plasmas as Scattering and Reflection Elements for Standoff Infrared Spectroscopy¹

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ABSTRACT

Femtosecond laser filamentation can serve as an enabling technology for remote sensing in the analysis of remote materials and atmospheric trace species with techniques such as LIBS for atomic species determination, LAMIS for isotopic ratio analysis, and supercontinuum-based DIAL for atmospheric trace species analysis. In addition, femtosecond filaments can be selectively generated in space and time at distances of ≥ 100 m, allowing for controllable dynamic placement of laser plasmas in free space. We propose the use of free space laser plasmas produced in atmosphere as controllable standoff scattering and reflection elements for the dynamic redirection and collection of spectroscopic signatures. In this study, we characterize the scattering properties of femtosecond filaments and nanosecond laser breakdown plasmas to infrared laser light in the range 1.9" to 4.4"m and at 10.6"m, including the dynamic evolution of angular scattering profiles. Results are reported as functions of incident wavelength, pump-probe delay, and pump-probe spatial overlap. For the first time, a spectroscopic measurement is conducted by measuring backscattered light from a free space laser plasma. Plasma-reflected gas phase tunable laser absorption spectroscopy for quantitative measurement of CO₂ concentration is reported. Implications to optical sensing technologies are discussed.

Keywords: Remote sensing, infrared, spectroscopy, femtosecond filament, backscattering, laser plasma

REFERENCES

- [1] Meehan, K. C., Zhang, B., Chirinos, J., Mao, X., and Zorba, V., "Free space laser plasmas as scattering and reflection elements for standoff IR spectroscopy," in [*Frontiers in Ultrafast Optics: Biomedical, Scientific, and Industrial Applications XXVI*], Herman, P. R., Osellame, R., and Ben-Yakar, A., eds., **PC13883**, PC138830D, International Society for Optics and Photonics, SPIE (2026). DOI: <https://doi.org/10.1117/12.3082879>.

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