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High-Efficiency Narrow-Bandwidth KTP Optical Parametric Oscillator for kHzâ€“MHz Planar Laser Induced Fluorescence

Narrowband KTP optical parametric oscillator improves PLIF efficiency 3–4× with higher repetition rates and 20× lower linewidth for flow diagnostics.

There is a need for spatiotemporally resolved diagnostic tools for use in hypersonic and turbulent flow fields to better understand flow and combustion interactions, as well as a need in chemistry to identify chemical species within a predefined space. The current conventional method is planar laser induced fluorescence (PLIF), a non-intrusive laser diagnostic technique that works by using a laser pulse to excite a chemical species and cause it to fluoresce. More specifically, the laser beam enters a nonlinear crystal structure, contained within the optical parametric oscillator, and produces a high-energy, tunable, and narrowband beam for excitation of chemical species. Early implementations of this method are limited in repetition rate and/or pulse energy, as the crystal used in these implementations is composed of barium beta borate. Researchers at Purdue University have developed a new optical parametric oscillator based upon an alternative crystal with improved spectral properties, 2.5x lower cost, and non-hygroscopic properties, thus removing the requirement for reactions to occur at elevated temperatures or within sealed cavities. This technology can improve upon the repetition rate at a relevant pulse energy and has a tunable wavelength emission, although it currently is optimized for UV wavelengths.

Technology Validation:

-Two tunable lasers used in test cases to confirm high repetition rate, good beam quality, and applied to a rotating detonation combustor (RDC) to test visualization of chemical species

Advantages

-3 - 4x increase in efficiency of conversion of laser wavelength for this OPO as opposed to conventional OPOs

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Category
Biotechnology & Life Sciences/Biomarker Discovery & Diagnostics
Aerospace & National Security/Hypersonics & Propulsion Systems
Aerospace & National Security/Thermal Management & Combustion Optimization

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View online

-Linewidth of OPO is 20x lower than conventional OPOs

Applications

-Chemical species identification in flow or combustion reactions

Related Publications:

Webb et al., Optics Letters, Vol. 49 (2024) https://doi.org/10.1364/OL.510334

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Intellectual Property:

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