Recent Advances in Coherent Anti-Stokes Raman Scattering and High-Speed Burst-Mode Diagnostics: Characterization of Combustion Environments

Hans U. Stauffer
Spectral Energies, LLC, 4065 Executive Dr., Beavercreek, OH, USA
hans.stauffer@spectralenergies.com

ABSTRACT

Revolutionary advances in both ultrashort-pulse (femtosecond) and high-repetition-rate (burst-mode) lasers are driving the advancement of existing diagnostic techniques and enabling the development of new measurement approaches for the detailed study of the chemistry and physics of reacting flows and plasmas. The high pulse-repetition rates of femtosecond- (fs-) duration amplifiers as well as nanosecond- (ns-) and picosecond- (ps-) pulse burst-mode lasers allow previously unachievable data-acquisition bandwidths for the study of turbulent time series and combustion instabilities. Ultrashort pulses afforded by fs laser systems also provide both tremendous peak powers—allowing nonlinear signal generation with broad spectral coverage—and unprecedented temporal resolution that provides freedom from collisional-quenching effects for studies of chemical kinetics and dynamics. Recent developments in fs time-resolved thermometric approaches, including coherent anti-Stokes Raman scattering (CARS), will be discussed, emphasizing advancements toward simultaneous detection of local temperature and concentration of minor, combustion-relevant species as well as extension toward high-pressure measurements. Such advances, when coupled with recent developments in burst-mode laser technology, will pave the way toward high-dimensional measurement capabilities at dynamic rates of hundreds of kHz and potentially into the MHz regime.