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Thermal Effects in Molecular Gas-Filled Hollow-Core Fibers[1]

NRISIMHA MURTY MADUGULA, JOHN BEETAR, YANGYANG LIU, Department of Physics, University of Central Florida, MICHAEL CHINI, Department of Physics, and CREOL, University of Central Florida — High average-power ultrafast laser sources based on Yb technology are a promising avenue for the generation of isolated attosecond pulses at high repetition rates. So far, compression to few-cycle durations has largely relied on employing large levels of nonlinearity, prolonged interaction lengths, or multiple compression stages due to their >100 fs output laser durations. At these durations, pulses can be more efficiently compressed through nonlinear propagation in molecular gases, where the field-driven rotational alignment on timescales shorter than the laser pulse duration enhances the optical nonlinearity. However, the thermal effects associated with the additional internal degrees of freedom in molecular gases, and their impact on spectral broadening in gas-filled hollow-core fiber, have not been explored. Here we present measurements of the average power dependent spectral broadening in an N_2O-filled hollow-core fiber. We find that high rotational temperatures severely limit the broadening at high average powers, and we demonstrate the effect buffer-gas cooling has on mitigating the thermal effects, leading to an improved transmission and beam profile without active cooling.

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