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Generation of Ultra-Broadband Supercontinuum Ultrashort Laser Pulses with High Energy

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Abstract : The interaction of intense short nano- and picosecond laser pulses with plasma leads to reach variety of important applications, including time-resolved laser induced breakdown spectroscopy (LIBS), soft x-ray lasers, and laser-driven accelerators. The progress in generating of femtosecond down to sub-10 fs optical pulses has opened a door for scientists with an essential tool in many ultrafast phenomena, such as femto-chemistry, high field physics, and high harmonic generation (HHG). The advent of high-energy laser pulses with durations of few optical cycles provided scientists with very high electric fields, and produce coherent intense UV to NIR radiation with high energy which allows for the investigation of ultrafast molecular dynamics with femtosecond resolution. In this work, we could experimentally achieve the generation of a two-octave-wide supercontinuum ultrafast pulses extending from ultraviolet at 3.5 eV to the near-infrared at 1.3 eV in neon-filled capillary fiber. These pulses are created due to nonlinear self-phase modulation (SPM) in neon as a nonlinear medium. The measurements of the generated pulses were performed using spectral phase interferometry for direct electric-field reconstruction. A full characterization of the output pulses was studied. The output pulse characterization includes the pulse width, the beam profile, and the spectral bandwidth. Under optimization conditions, the reconstructed pulse intensity autocorrelation function was exposed for the shorts possible pulse duration to achieve transform-limited pulses with energies up to 600μJ. Furthermore, the effect of variation of neon pressure on the pulse-width was studied. The nonlinear SPM found to be increased with the neon pressure. The obtained results may give an opportunity to monitor and control ultrafast transit interaction in femtosecond chemistry.

Keywords : femtosecond laser, ultrafast, supercontinuum, ultra-broadband
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