High-Order Harmonic Generation in the Nonadiabatic Regime in a Sub-mm Glass Chip

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The wide applications of table-top attosecond extreme ultraviolet (XUV) and soft X-ray sources is leading to a constant optimization in terms of photon flux, maximum reachable photon energy, and brightness. In this contribution, we present an efficient configuration for high-order harmonic generation (HHG) exploiting the so-called nonadiabatic regime implemented in a glass cell.

This condition is obtained with a high intensity driving field at the interaction point (up to 10^{16} W/cm^2) focused into a laser micromachined glass chip for highly confined gases. The chip was obtained adapting our previous design for third harmonic generation, and it consists of a single channel of 400 µm inner diameter with a tapered entrance of 300 µm, and a total length of 900 µm placed on top of the gas reservoir cylinder having the same diameter. This cell can sustain high gas pressures up to several bars.

The device was employed for HHG using 800-nm driving pulses of 30-fs duration in both Argon (1.8 bar) and Neon (2 bar), and an energy per pulse of 1.4 mJ. Cut-off extensions up to 100 and 180 eV were obtained with respect of adiabatic HHG conditions for Ar and Ne gases, respectively. Further measurements were performed with the output of a two stages CEP-stable optical parametric amplifier (OPA) at 1500-nm central wavelength, providing pulses of 35 fs without further compression and an energy at the generation focus of 500 µJ. To our knowledge, this result is the first ever nonadiabatic generation process with driving wavelengths >1030 nm. These achievements highlight the possibility of covering the full water-window spectral region with long pulses and without the use of Helium.