Development of an intense few-cycle light source in the infrared and its application to ultrafast soft x-ray spectroscopy of nitric oxide and nitrogen dioxide

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Abstract:

Recent advance in the development of intense (few-cycle) light sources in the near- to mid-infrared region of the spectrum has triggered strong-field experiments in gaseous media as well as in solids. Conventional Ti:sapphire lasers have been frequently used to produce high harmonics and attosecond pulses in the extreme ultraviolet region. Because the operation wavelength of Ti:sapphire lasers stays around 800 nm, it has not been possible to extend further the cutoff energy of high harmonics toward the soft x-ray spectral region. To overcome this limitation, an intense, few-cycle, infrared light source (1.5 mJ, 10 fs, 1600 nm, 1 kHz) has been developed based on an optical parametric chirped-pulse amplifier with bismuth triborate (BiB_3O_6, BIBO) crystals pumped by a Ti:sapphire chirped-pulse amplification laser. Using the infrared light source, we demonstrate the generation of carrier-envelope phase-dependent high harmonics beyond the carbon K edge (284 eV), which is the low energy edge of the water window region (284 – 540 eV). Furthermore, the generated soft x-ray high harmonics have been applied to measure the ultrafast electron and nuclear dynamic of nitric oxide and nitrogen dioxide upon photo ionization using a soft x-ray continuum around the nitrogen K edge (400 eV) as a probe.