High power KTA-based OPA at 3.2 μm at 1 kHz

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The recent advances in high harmonic generation (HHG) have shown that ultrafast X-ray spectroscopy such as absorption spectroscopy (XAS) is possible in the water window (284-540 eV) [1]. Such laser-based ultrafast XAS has advantages over conventional XAS using accelerator-based synchrotron sources and XFELs in their compactness and capability to reach attosecond time scales. However, maintaining a practical photon flux for XAS while extending the cutoff energy of high harmonics beyond the water window remains a big challenge. It is because the conversion efficiency scales as $\sim\lambda^{-5.5}$ while the cutoff photon energy scales as λ^2. Therefore, high-average-power intense MIR sources are required. Such MIR sources are also useful to explore strong field physics in condensed matters because their small photon energies can avoid multiphoton ionization and carrier generation. High harmonic generation in solids and liquids has been demonstrated with intense MIR sources at field amplitudes above >10 MV/cm, where extreme nonlinearity of matter emerges.

In this work, a three-stage KTA-based optical parametric amplifier (OPA) that is pumped by a Ti:sapphire laser amplifier (800 nm, 12 mJ at 1 kHz), following a previously-developed two-stage OPA with a lower power Ti:sapphire laser (800 nm, 3.3 mJ, at 450 Hz) [2]. A 4-mm-thick YAG plate is used for white light generation, and the 1100-nm component is amplified at the first and second stage noncollinear OPAs. The idler component at 3.2 μm in the third-stage collinear OPA is separated from the pump and signal pulses. The output energy of the MIR idler pulses has reached 370 μJ.

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[2] F. Lu and P. Xia *et al.*, Opt. Lett. **43**, 2720 (2018).