Ultrafast 2 μm ZBLAN Fiber Lasers

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Holmium (Ho)-doped lasers operating around 2 μm are promising sources for high-field physics due to their high emission cross-section and minimal water vapor absorption. However, generating sub-100-fs pulses in these lasers has been challenging due to Ho's narrow gain bandwidth. To overcome this limitation, we report a novel femtosecond oscillator at ∼2.1 μm based on a thulium (Tm)- and Ho-doped double-clad fluoride fiber (Tm:Ho:ZBLAN) pumped at 0.79 μm. While previous work with Ho-doped silica fibers yielded pulse durations limited to 160 fs, we leveraged the lower anomalous dispersion of fluoride fibers, building upon our prior success in generating 45 fs pulses with Tm-doped fluoride lasers. Our ring cavity oscillator, mode-locked via nonlinear polarization rotation, generated 349 fs pulses with 179 mW average power at 76.5 MHz using a Tm:Ho:ZBLAN fiber with a dispersion of -0.013 ps^2. Crucially, by employing external linear dispersion compensation with BK7 plates, we achieved a record-short pulse duration of 74 fs directly from a Ho-doped fiber laser oscillator, without the need for external nonlinear spectral broadening.