

Relative intensity noise properties of a diode-pumped Cr:ZnS femtosecond oscillator

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Cr-doped chalcogenides have great potential for ultrashort pulse generation in the mid-infrared (mid-IR) wavelength region of 2-3 μm [1]. Nowadays Cr:ZnS/Se femtosecond lasers are expected to become excellent drivers for high harmonics generation as well as for frequency down-conversion into the “molecular fingerprint region”, due to their relatively long wavelengths, broadband emission spectra and few-cycle temporal durations.

So far, we have developed self-start, mode-locked Cr:ZnS lasers by utilizing an erbium-doped fiber laser as a pump source and single-walled carbon nanotube (CNT) as a saturable absorber [2,3]. Toward the applications mentioned above, relative intensity noise (RIN) properties are crucial. Diode-pumping may suffer from non-diffraction limited beam quality but possesses advantages of high energy efficiency, low cost, compactness and low RIN [4]. In this work, we investigate RIN properties of diode-pumped mode-locked Cr:ZnS oscillators, where each of Kerr-lens mode-locking (KLM) and CNT mode-locking are exploited.

The laser setup is shown in Fig. 1a. Our Cr:ZnS femtosecond oscillator is pumped by the combination of two InP single-emitter diodes centered at 1650 nm. With a 10% output coupler (OC), the KLM oscillator has a mode-locked average power of 520 mW, repetition rate of 140 MHz and pulse duration of 75 fs. To achieve CNT mode-locking in the same oscillator, 2-mm CaF_2 plate was replaced by another 2-mm CaF_2 plate with a CNT film. The CNT mode-locked oscillator gives a mode-locked average power of 280 mW and pulse duration of 83 fs. Figure 1b displays the measured RIN for each of the pump LD, CNT mode-locked output, and KLM output. We can see that the noise peak at hundreds of kHz, typically observed for Er:fiber lasers due to relaxation oscillations, is absent for the measured RINs displayed in Fig. 1b. It is also found that RINs of the mode-locked outputs are suppressed at above 1 MHz compared with the pump LD. CNT mode-locking and KLM exhibit very similar RIN properties except that the former exhibits a peak at approximately 1 MHz.

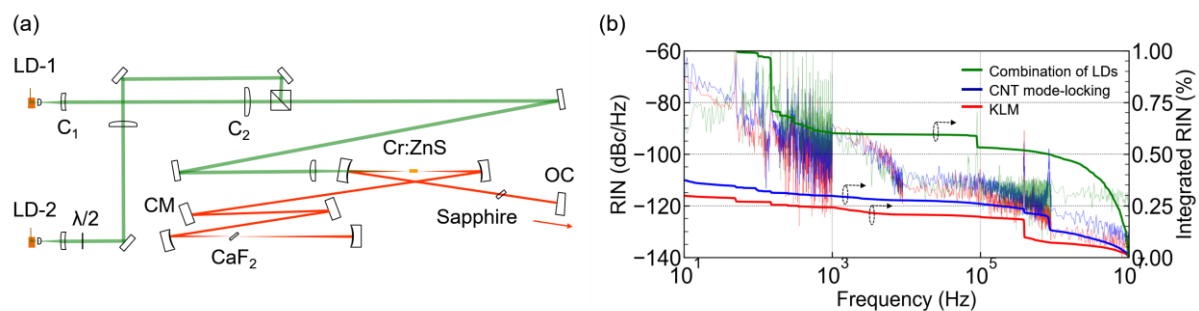


Fig. 1. (a) An experimental setup of the diode-pumped Cr:ZnS oscillator. CM: chirped mirror. C_1 and C_2 : cylindrical lenses. (b) The measured RINs for the pumping LDs, CNT mode-locked output, and KLM output.

References

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