Passively synchronized Q-switched and simultaneous mode-locked dual-band Tm^{3+}:ZBLAN fiber laser at 1.48- and 1.85-μm using common graphene saturable absorber

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change of graphene transmission loss. As P_{1064} increases from 526 mW to 574 mW, Q-switched pulses at 1480 nm are observed with a fixed repetition rate of ~20 kHz. During this process, these two cavities both produce ~20 kHz Q-switched pulses. As P_{1064} increases further up to 682 mW, repetition rates of Q-switched pulses at 1480 nm and 1850 nm both simultaneously increase from 20 kHz to 40.5 kHz, indicating pulses from the 1850 nm loop follows the repetition rate of the

for lasing operations at 1480 nm and 1850 nm, respectively, along with one common branch including the graphene SA and one output coupler. The same gain fiber and lengths used for the previous dual-band Q-switched laser are used again for the 1480 nm and 1850 nm branches, respectively. Two gold-tipped mirrors serve as two reflectors to form one end of each cavity and two circulators designed for operation at 1480 nm or 1850 nm are used to ensure unidirectional propagation and to allow for light oscillation in each linear cavity.

Fig. 3. (a) Experimental setup of the simultaneous mode-locked Tm^{3+}:ZBLAN fiber laser; (b) optical spectrum and (c) mode-locked pulse trains when P_{1064} = 694 mW and P_{1560} = 1320 mW.

Fig. 3(b) shows the full optical spectrum in a 600-