Electronic Supplementary Material (ESI) for Nanoscale.

MoS_2 nanoflowers as high performance saturable absorbers for all-fiber passively Q-switched erbium-doped fiber laser

Rongfei Wei [a], Hang Zhang [a, *], Xiangling Tian [a], Tian Qiao [a], Zhongliang Hu [a], Zhi Chen [a], Xin He [b], Yongze Yu [a], and Jianrong Qiu [a, *]

[a]State Key Laboratory of Luminescent Materials and Devices, Guangdong Engineering Technology Research and Development Center of Special Optical Fiber Materials and Devices,and Guangdong Provincial Key Laboratory of Fibers Laser Materials and Applied Techniques, South China University of Technology, Wushan Road 381,Guangzhou 510641, PR China

[b]School of Applied Physics and Materials, Wuyi University, Jiangmen 529020, PR China

**mshz@scut.edu.cn*

**qjr@scut.edu.cn*

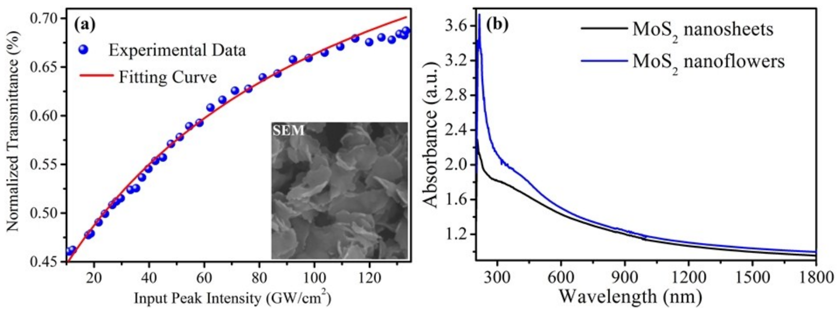

Fig. S1 (a) Normalized transmission as a function of input peak intensity for the layered MoS_2/PVA composite film under the excitation of 130 fs pulses at 800 nm, the inset is SEM of the layered MoS_2. (b) UV-vis absorption spectrum of the MoS_2 nanoflowers and nanosheets.

The layered MoS_2 was also prepared via the hydrothermal method. 0.6180 g ammonium molybdate tetrahydrate and 1.1420 g of thiourea were dissolved in 35 mL distilled water. After stirring for 30 minutes, the solution was removed to a 50 mL Teflon-lined stainless steel autoclave and heated at 200 ℃ for 24 h, then cooled down to room temperature naturally. The resulting precipitate was rinsed with ethanol by five times and finally dried at 60 ℃ for 1 h under vacuum.

The inset of Fig. S1 presents SEM images of the MoS_2 product, which clearly demonstrate that the layered MoS_2 were successfully prepared.

The variation of the normalized transmittance with the input peak intensity for the layered MoS_2/PVA composite film was depicted in Fig. S1. The modulation depth of 53.4% and saturation intensity of 101.1 GW/cm^2 were obtained fitting the data via the equation (2). Obviously, The value of saturation intensity is lower than that of MoS_2 nanoflowers. The high modulation depth and larger saturation intensity of the MoS_2 nanoflowers is very promising for application in Q-switcher to generate stable Q-switched pulses.

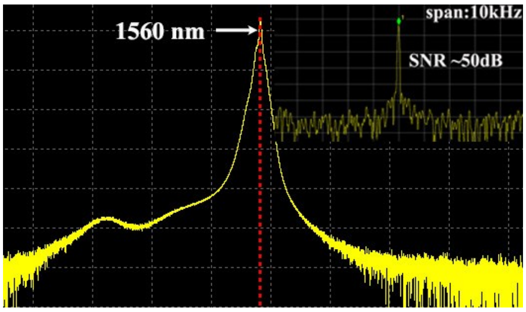

Fig. S2 Output spectrum of Q-switching pulse emitted from fiber laser using the layered MoS_2 nanosheets as a saturable absorber at the pump power of 21.02 mW; The inset is radio-frequency optical spectra at the 44.7 kHz with the span of 10 kHz.

Table S1 The repetition rate, pulse duration, output average power and pulse energy versus the pump power of the Q-switching pulses using layered MoS_2 nanosheets as a saturable absorber

Pump power (mW)	16.80	21.02	25.94	30.87	35.79
Repetition rate (kHz)	36.1	44.0	51.0	65.0	91.7
Pulse duration (μs)	5.1	3.9	3.2	3.4	3.7
Output power (mW)	0.525	0.630	0.875	1.080	1.060
Pulse energy (nJ)	14.54	14.32	17.16	16.62	11.56

As shown in Fig. S2 and Table S1, the passively Q-switched fiber laser pulses with layered MoS_2 at 1.56 μm with Q-switching threshold of 16.80 mW, signal-to-noise ratio of 50.0 dB, short pulse duration of 3.2 μs, highest output power of 1.08 mW and largest pulse energy about 17.16 nJ were attained, which are relatively poorer than that of nanoflowers-based saturable absorber. These performances of the Q-switched laser show good prospects of MoS_2 nanoflowers as an excellently saturable absorber in the future.