Supplementary Information for

Third-order optical nonlinearities of Nb$_4$C$_3$ MXene and its applications as an ultra-broadband mode-locker

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**Fig. S1.** (a) Measured AFM image of Nb$_4$C$_3$ MXene nanosheets. (b) Height profile of Nb$_4$C$_3$ Mxene of (a) Section 1, (b) Section 2, and (c) Section 3 in Figure S1a.
Fig. S2. Experimental schematic of simultaneous detection of OA and CA Z-scan measurement of \( \text{Nb}_4\text{C}_3 \) MXene nanosheets at 1560 and 1910 nm. Atten, L, BS, A, and D denote the attenuator, lens, beamsplitter, and detector.
**Fig. S3.** A three-step procedure for the fabrication of a MXene-based SA, including a LPE process of Nb₄C₃ MXene, a mixing process with PVP solution, and a deposition process.
**Fig. S4.** Experimental schematic measuring nonlinear transmittance of Nb$_4$C$_3$ MXene nanosheet-based SA at 1560 and 1910 nm. PC, Atten, and D denote the polarization controller, attenuator, and detector.
**Fig. S5.** Experimental schematic of Nb$_4$C$_3$ MXene nanosheet incorporated optical fiber ring cavity. LD, WDM, RE-doped fiber, ISO, and PC denotes laser diode, wavelength division multiplexer, rare-earth-doped fiber, isolator, and polarization controller.
Fig. S6. The output optical spectrum measured at every 30 min. for 3 h at (a) 1560 nm and (b) 1930 nm.