

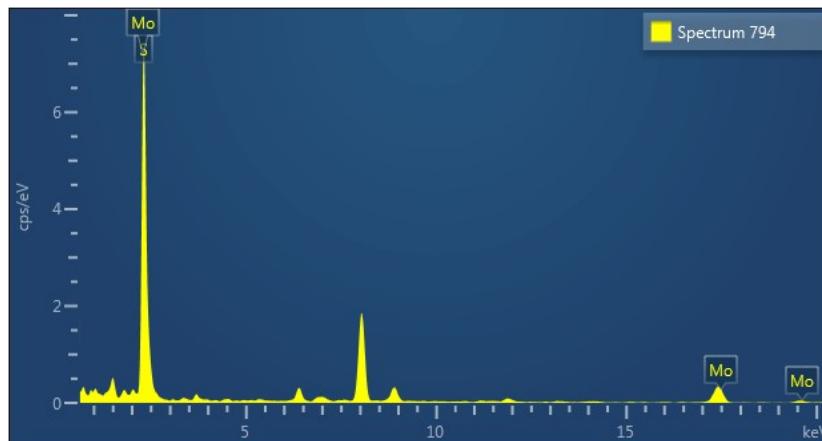
Supporting information

Characterization details

To confirm the exfoliation of MoS_2 nanosheets from the bulk counterparts, High-resolution transmission electron microscopy (HRTEM) measurements were carried out using a JEOL Japan JEM-2100 Plus instrument to visualise the nanosheets. Elemental composition of MoS_2 nanosheets were obtained from the energy dispersive X-Ray spectroscopy (EDS) from the HRTEM instrument. HORIBA LabRam HR Evolution Raman spectrometer was used to confirm the Raman active modes of MoS_2 nanosheets.

Investigations were carried out to understand the hybrid formation of MoS_2 -Carmine structures. The formed MoS_2 -Carmine hybrid was visualized using a Scanning electron microscopy using a Thermo Scientific Apreo-S HRSEM setup. Optical properties of all samples were studies using the Agilent Cary 60 instrument in the UV-Visible region from 200-800 nm. Using an FLS1000 PL spectrometer, photoluminescence measurements were carried out at their respective excitation wavelengths.

Open-aperture Z-scan measurements were conducted using a Q-switched Nd:YAG laser operating at a wavelength of 532 nm, delivering nanosecond pulses with a pulse width of approximately 9 ns at a repetition rate of 10 Hz. The laser beam was focused to a beam waist (ω_0) of 16.9 μm , yielding a corresponding Rayleigh range (z_0) of 1.69 mm. The samples were contained in a 1 mm path-length quartz cuvette and mounted on a computer-controlled motorized translation stage, which moved the sample along the beam propagation axis (z-axis) in uniform steps through the focal region. This configuration enabled precise measurement of nonlinear absorption behaviour across the focal plane.



Element	Line Type	k Factor	k Factor type	Absorption Correction	Wt%	Wt% Sigma	Atomic %
S	K series	1.000		1.00	46.35	3.47	72.11
Mo	K series	4.561		1.00	53.65	3.47	27.89
Total:					100.00		100.00

Fig.S1. Energy dispersive X-Ray spectroscopy (EDS) spectrum of synthesized MoS_2 nanosheets

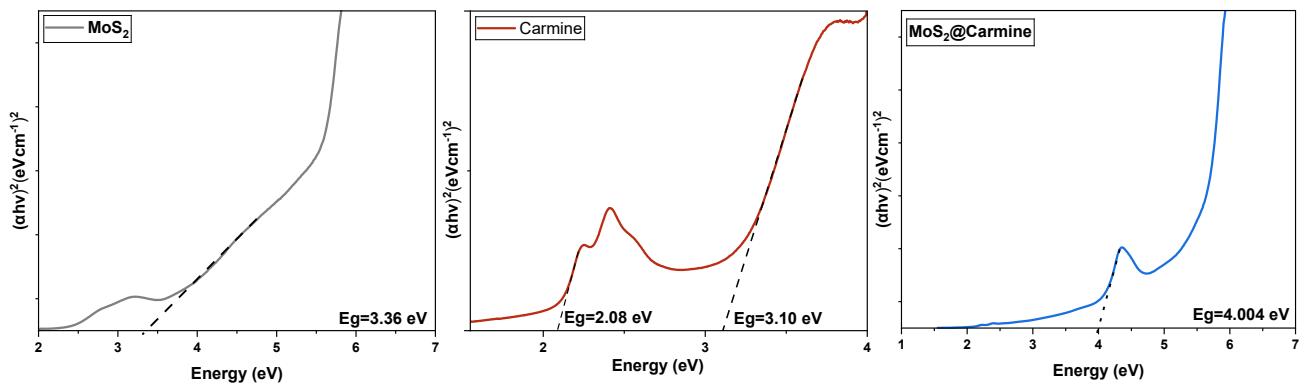


Fig. S2. Tauc plot depicting bandgap of all samples

Laser Parameters	Numerical Values
Wavelength	532 nm
Frequency	10 Hz
Pulse Rate	9 ns
Beam waist	$16.9 \mu\text{m}$
Path Length	1 mm
Rayleigh Range	1.69 mm
Focal Length	15 cm
Pulse energy	150uJ
Intensity	$3.69 \times 10^{12} \text{ W/m}^2$

Table S1. Laser parameters while conducting open-aperture Z-scan experiment