Supporting Information

Ultrathin Boron Nanosheets as An Emerging Two-Dimensional Photoluminescence Material for Bioimaging

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Experimental Section

Preparation of ultrathin boron nanosheets:

300 mg bulk boron powder (Macklin Inc., 99.9% purity) was directly added into 300 ml IPA solvent to form the suspension with an initial concentration of 1 mg/ml. Then the suspension was firstly treated with probe sonication with a power of 780 W for 1 h, with 3 s sonication and 8 s pause, and then followed by bath sonication with a power of 1050 W for 3 h. Noted that both the probe and bath sonication processes were conducted under a constant tempature of 10 ^{o}C. To obtain the ultrathin B NSs, the as-prepared B/IPA solution was firstly centrifuged at a low speed of 7000 rpm for 15 min to obtain the supernatant, and subsequently centrifugated at a high speed of 10000 rpm for additional 15 min to obtain the product. The as-prepared wet precipitate was diluted, sonicated, and then standing overnight for further fluorescence studies.

Characterization

The morphology and microstructure of boron nanosheets were examined by FESEM (JSM-7800F&TEAM Octane Plus), HRTEM (Tecnai G2 F30) and AFM (Dimension Edge, Bruker, America), respectively. The structure and Raman spectra were collected on X-ray diffraction (Bruker, D8 Advance with Cu-Kα radiation) and Raman microscope (DXR Thermo-Fisher Scientific) with an excitation wavelength of 532 nm. Optical absorption performances were measured by a UV-vis spectrum in the range of 300-800 nm. Fluorescence spectra was collected on a F7000 fluorescence spectrometer. X-ray photoelectron spectroscopy (XPS) tests were carried out using an ESCALAB 250Xi system, and all data were calibrated using adventitious C1s peak at a fixed value of 284.4 eV. Fourier infrared spectroscopy were recorded on a Varian 3100 FT-IR spectrometer in the range of 4000-500 cm^{-1}.

Cell viability

The cervical cancer cell line HeLa and hepatocarcinoma cell line Huh-7 were cultured in Dulbecco's modified Eagle's medium (Hyclone) supplemented with 10% fetal bovine serum (Gibco) and 1% penicillin/streptomycin (Gibco). For biocompatibility assay, cells were seeded in 96 well plates. Different concentrations of the material were added into the medium 24 h later. After incubation for another 24 h, CCK-8 assay was used to determine the viability of the cells following the instruction of the manufacturer (Beyotime). For bioimaging assay, HeLa cells were seeded in glass bottom dishes (Thermofisher). The material was functionalized with mPEG-NH_2 (Ruixi). After incubating with the material for 4 h, cells were washed with PBS and imaged with confocal microscopy (Leica).

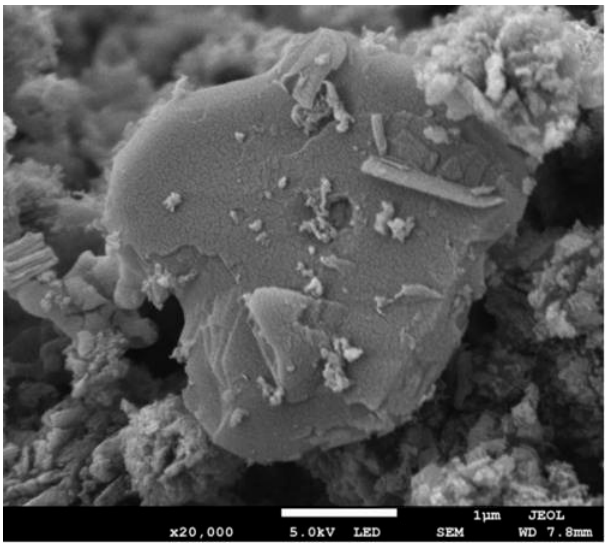

Figure S1 FESEM image of the bulk B powder.

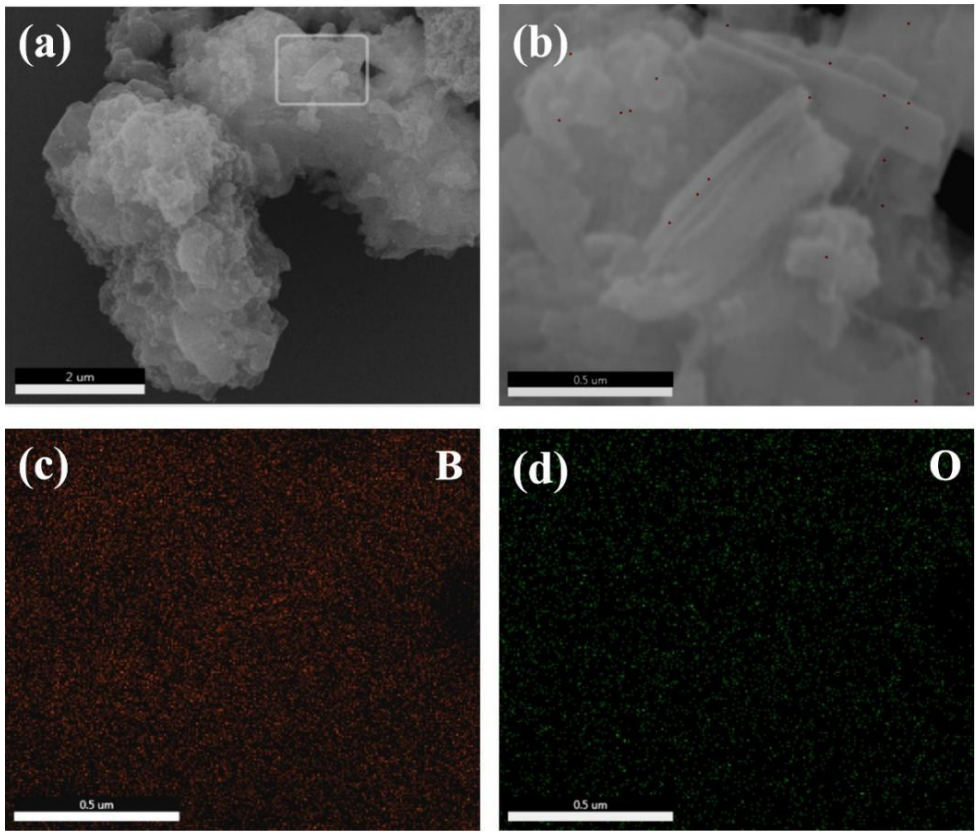

Figure S2 (a, b) The FESEM images of ultrathin B nanosheets, and the corresponding EDS mapping of (c) B and (d) O elements.

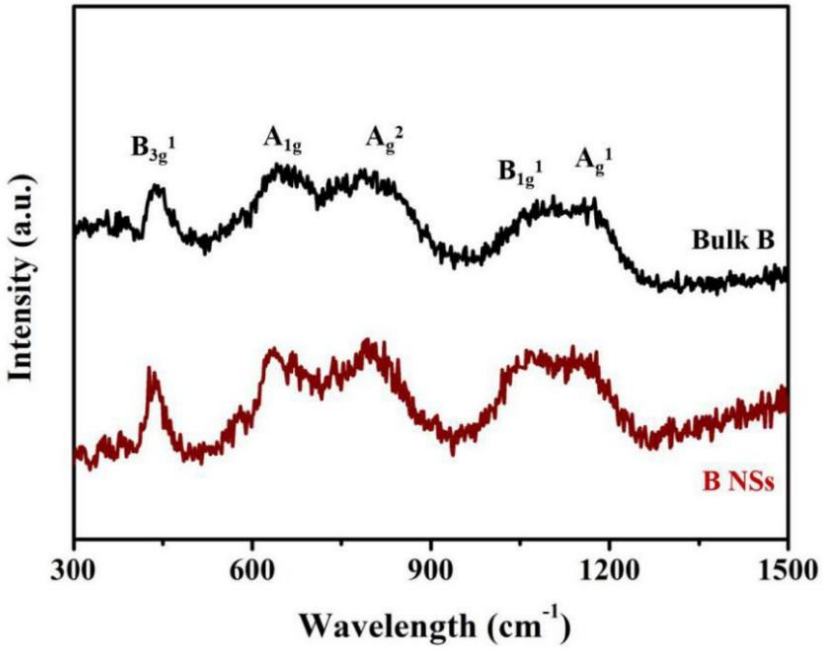

Figure S3. Raman spectra of the bulk B and ultrathin B nanosheets.

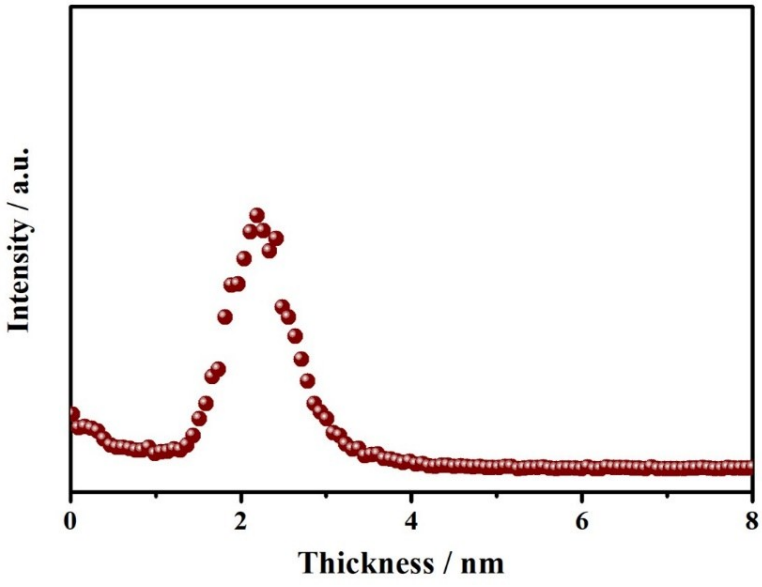

Figure S4 The thickness distribution of ultrathin B nanosheets.

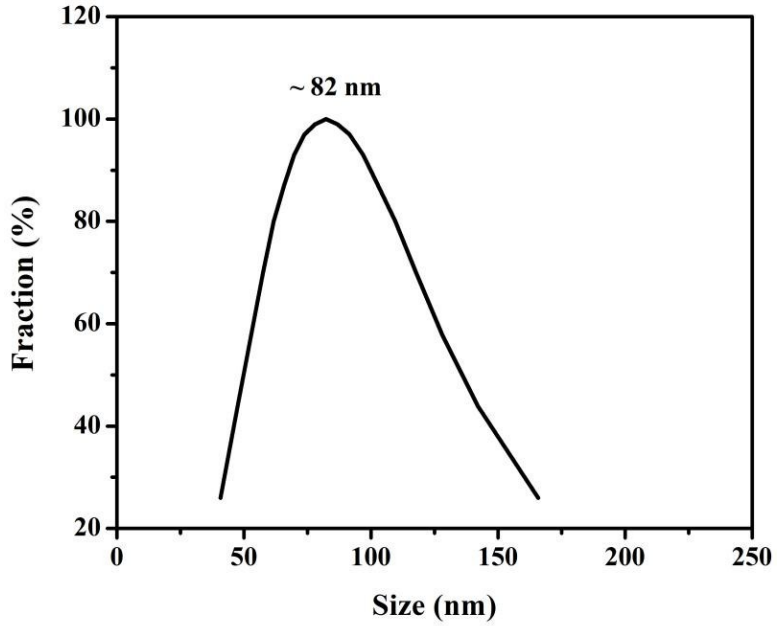

Figure S5 The size distribution of ultrathin B nanosheets.

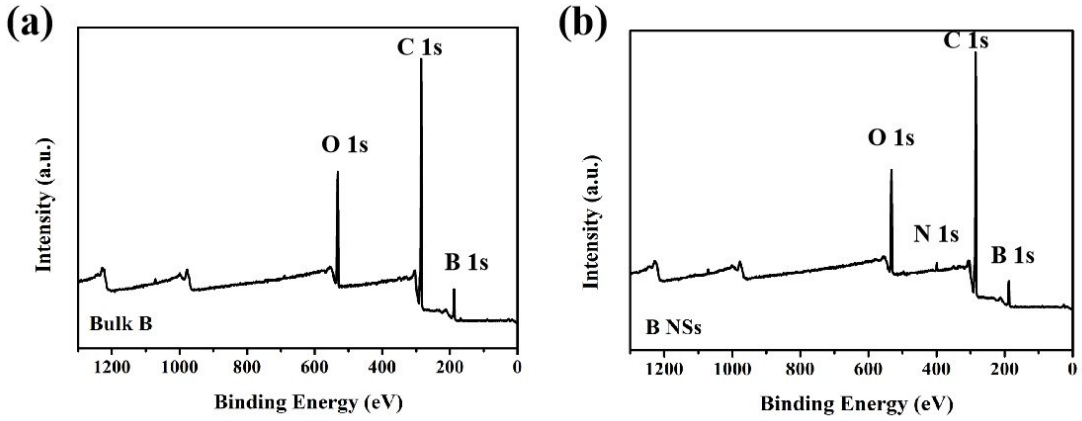

Figure S6. The XPS full spectrum of (a) bulk B and (b) ultrathin B nanosheets.

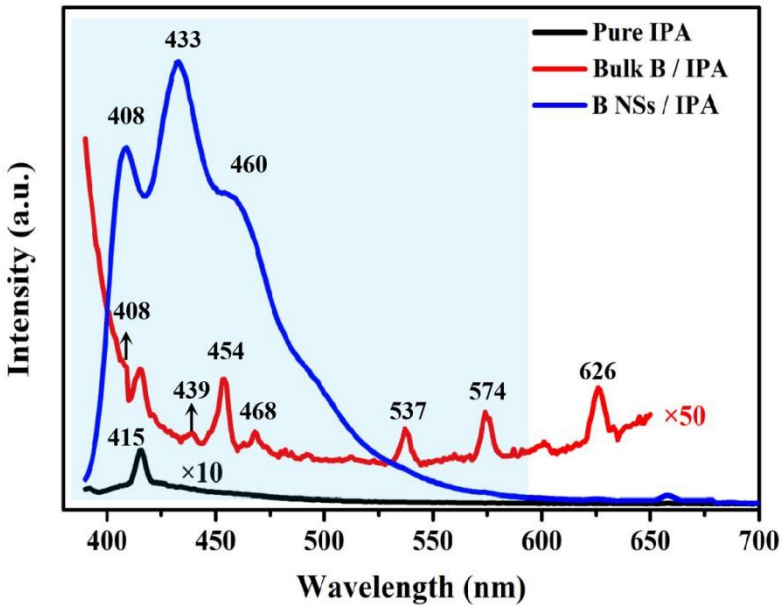

Figure S7. The fluorescence spectra of pure IPA, bulk B/IPA and ultrathin B nanosheets/IPA.

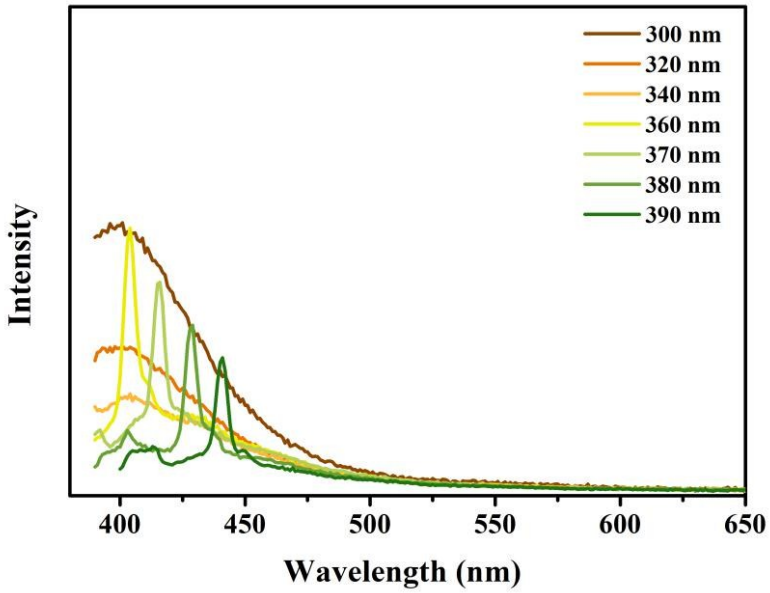

Figure S8. The fluorescence spectra of pure IPA solvent excitated under the wavelength from 300-390 nm.

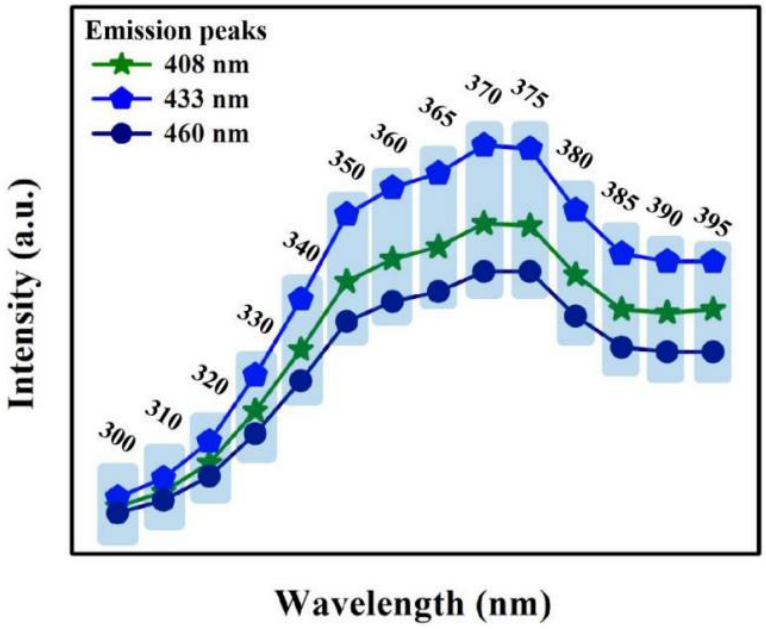

Figure S9 The comparision of emission intensity of ultrathin B nanosheets/IPA solution under different wavelength of excitation light.

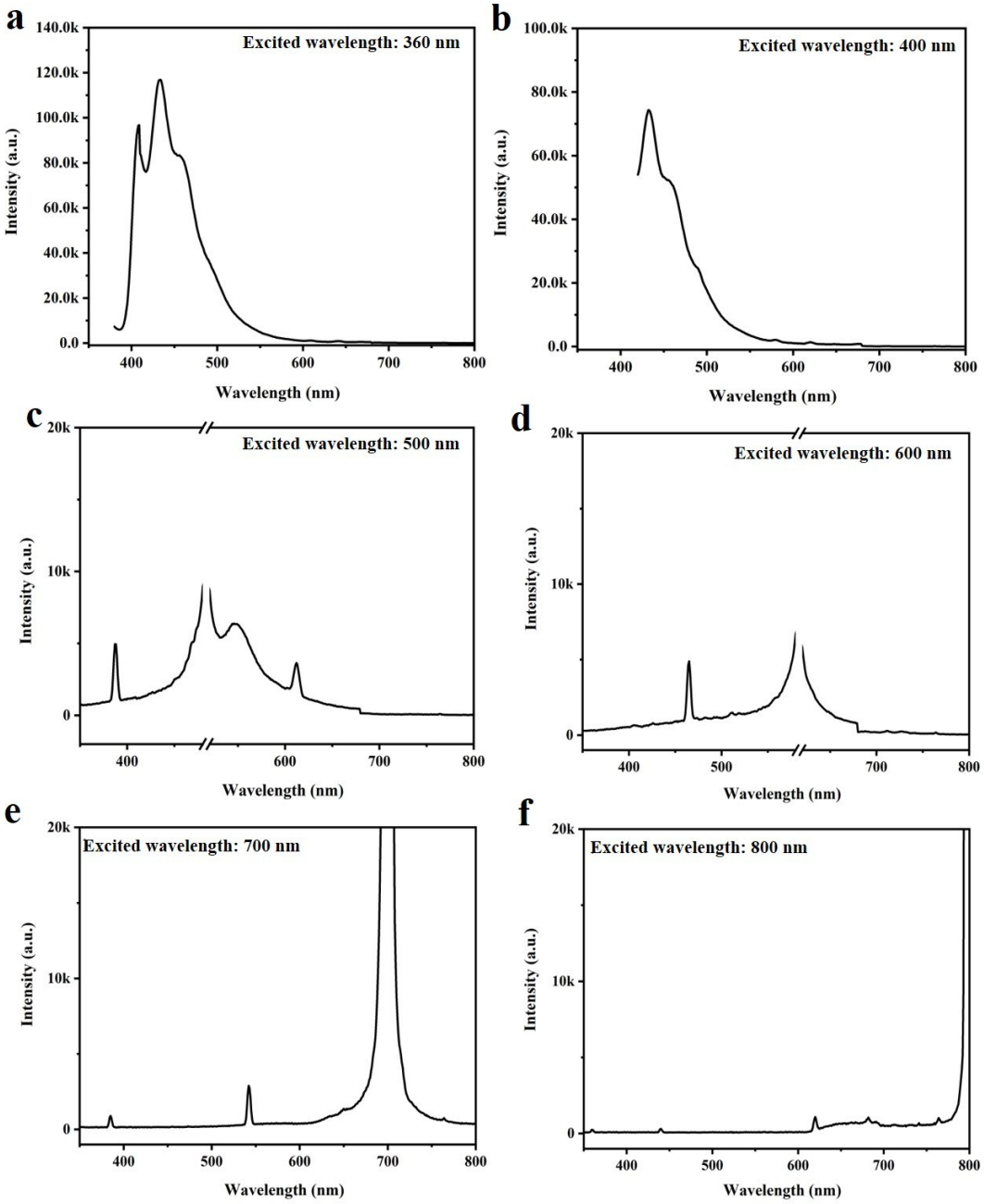

Figure S10 The fluorescence spectra of ultrathin B nanosheets/IPA excitated under the wavelength of (a) 360 nm, (b) 400 nm, (c) 500 nm, (d) 600 nm, (e) 700 nm, and (f) 800 nm.

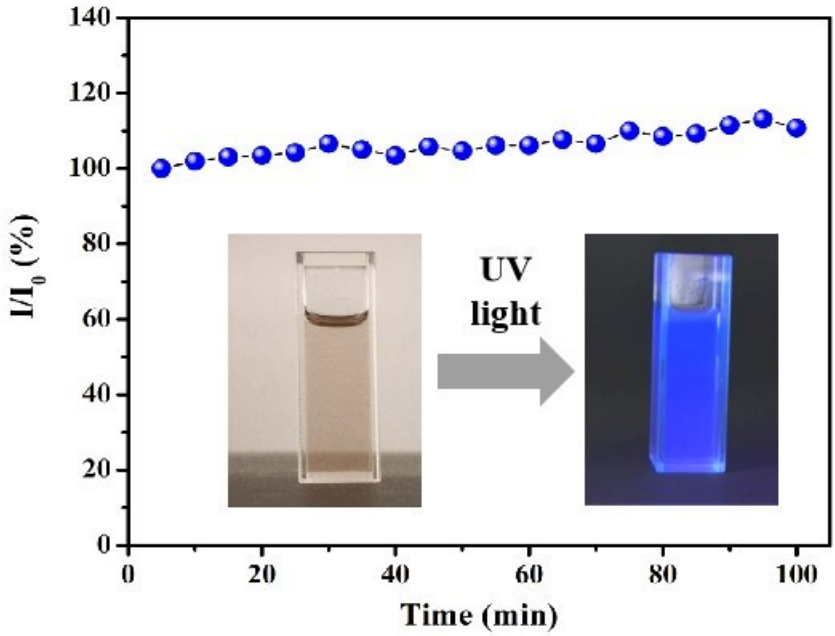

Figure S11 Time dependence of fluorescent intensity of ultrathin B nanosheets after the UV-light illumination with 56 mW.

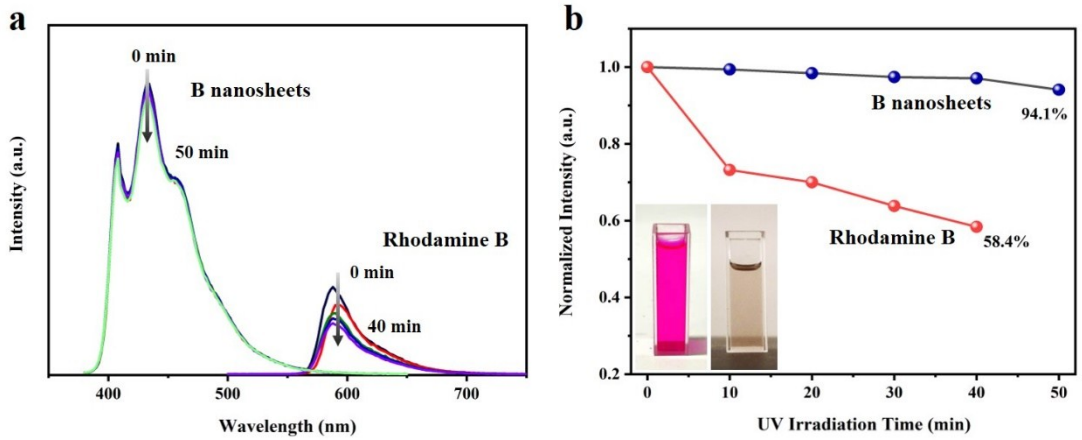

Figure S12 (a) PL emission spectra and (b) the corresponding normalized PL intensity of B nanosheets and Rhodamine B solutions irradiated by a 300 W xenon lamp for different times.

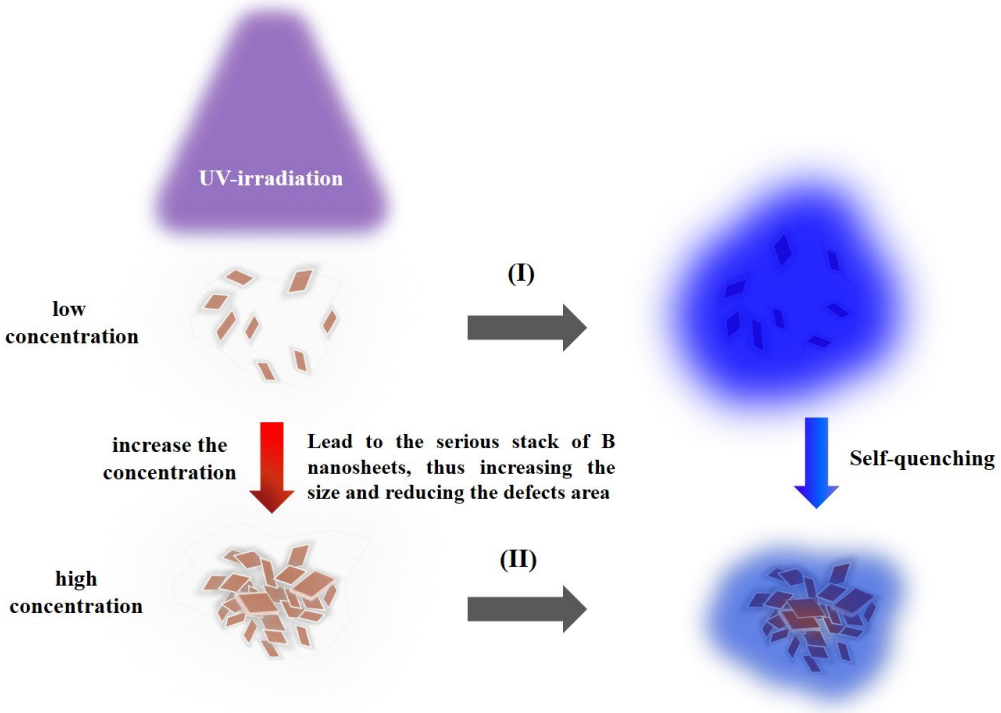

Figure S13 The possible schematic diagram of the relationship between concentration and luminescence characteristic in ultrathin B nanosheets/IPA solution.

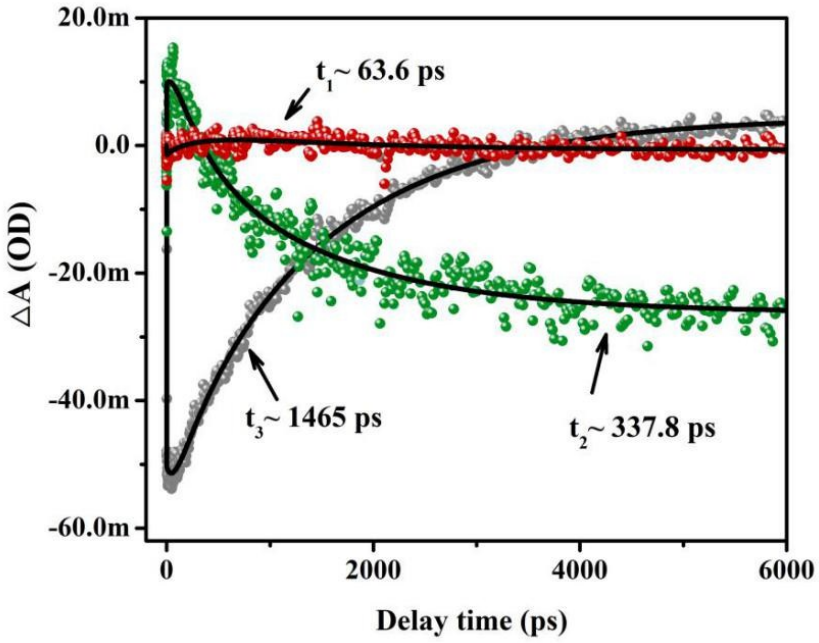

Figure S14 The global fitting curve of ultrathin B nanosheets.

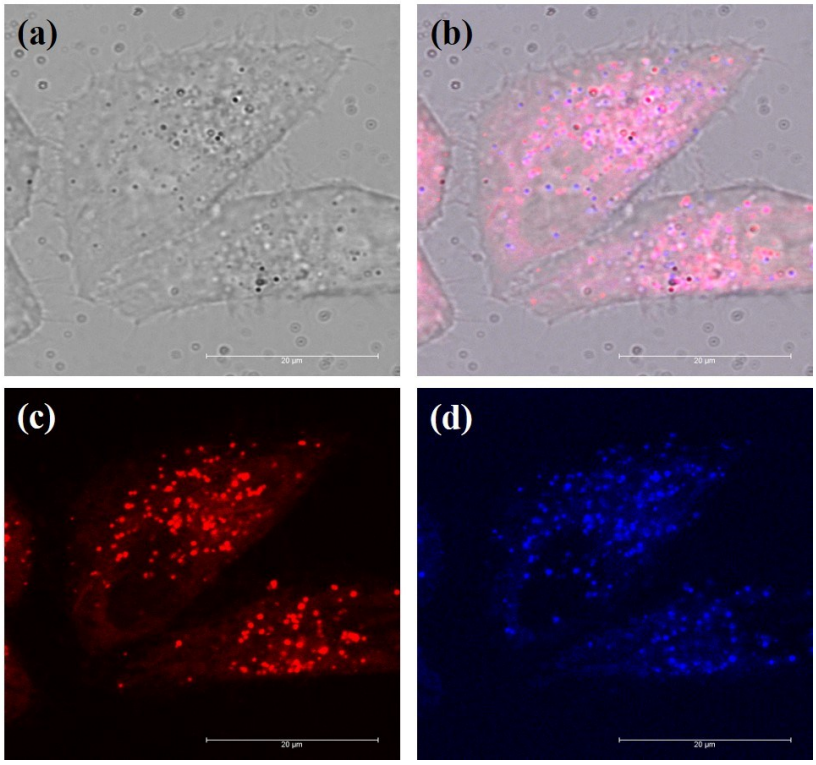

Figure S15. For lysosome detection, the HeLa cells were treated with B nanosheets for 4 h and then were treated with Lyso-Tracker probes for 30 min. (a) the bright field image; (b) the merge image of bright field, Lyso-Tracker and ultrathin B nanosheets; the confocal images of (c) Lyso-Tracker and (d) ultrathin B nanosheets.

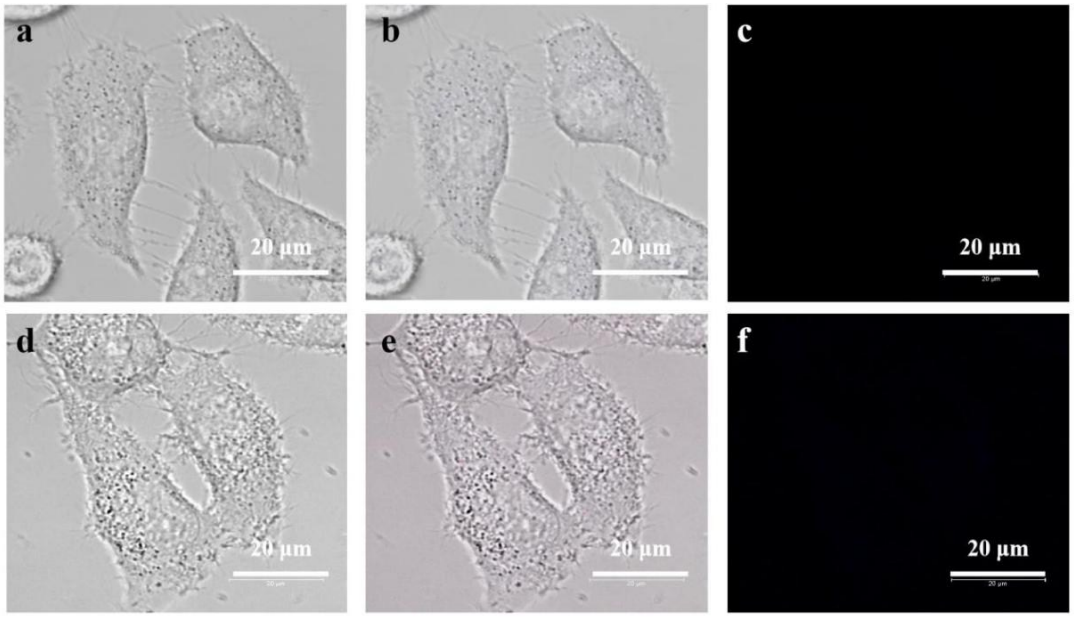

Figure S16. The bright field images with corresponding overlay images of the (a, b) HeLa cell, and (d, e) Huh-7 cell. Confocal laser scanning microscopy images of the (c) HeLa cell and (f) Huh-7 cell incubated without the adding of ultrathin B nanosheets.

Table S1. The comparison of ultrathin B nanosheets with the previous reports, in terms of the PL quantum yield.

Materials	Excitation wavelength	PL Quantum yield	References
Au nanoclusters	400 nm	1.3%	1
MoS_2 quantum dots	575 nm	4.4%	2
WS_2	447 nm	~6%	3
Ti_3C_2 MXene quantum dots	320 nm	9.9%	4
Graphene quantum dots	365 nm	3.8%	5
Nitrogen-doped carbon dots	365 nm	13.9%	6
Graphene quantum dots	375 nm	11.4%	7
Boron nanosheets	370 nm	10.6%	This work

References

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