

Supporting Information

Hollow NaBiF₄:Tb nanoscintillator with ultra-weak afterglow for high-resolution X-ray imaging

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Experimental Procedures

Materials

Ethylene glycol (EG, 98%), Bi(NO₃)₃·5H₂O (99.99%), Tb(NO₃)₃·5H₂O (99.9%) were purchased from Aladdin. NaCl (99.9%) and NH₄F (98%) were obtained from Macklin. All the reagents listed above were used without further purification. The frozen bullfrog was purchased from a shop.

Synthesis

Synthesis of NaBiF₄:15Tb NSs. Preparation process of NaBiF₄:15Tb NSs is described as follows. First, Bi(NO₃)₃·5H₂O (0.85 mmol), Tb(NO₃)₃·5H₂O (0.15 mmol) and NaCl (2 mmol) into 10 mL EG as the stock solution A. NH₄F (24 mmol) was dissolved in 20 mL EG to form stock solution B. Second, solution B were added sequentially to the reaction system and vigorously stirred for 10 min. After stirring uniformly, the mixed solution was transferred to a centrifuge tubes (50 mL). Next, the samples were washed four times with anhydrous ethanol, collected through centrifugation. Finally, the products were dried at room temperature.

Synthesis of NaBiF₄: 15Tb film. Polymethyl methacrylate (PMMA, 100 mg) and 1 mL toluene were mixed, which then were stirred to form a transparent solution. 30 mg NaBiF₄ NSs was added into the above PMMA toluene solution, which then was stirred for more than 3 h to generate uniform paste product without agglomerate. The resultant product was transferred into a designed mold, which then volatilized at room temperature for 12 h until the film was formed.

Characterizations

X-ray diffraction (XRD) analysis was carried out by a powder diffractometer (Bruker D8

Advance) with a Cu-K α ($\lambda = 1.5405 \text{ \AA}$) radiation. The morphology and size of the products were characterized by a field emission transmission electron microscopy (TEM, FEI Tecnai G² F20) equipped with an energy dispersive X-ray spectroscopy (EDS, Aztec X-Max 80T). XEOL spectra were measured by a spectrometer (OmniFluo960 X-ray, Zolix, China) with an X-ray tube (target material: W, voltage 50 kV, tube current 200 μA) and a photon counter (DCS210PC-9S). X-ray imaging was performed by a miniature X-ray tube (target material: Au, voltage: 30 kV, tube current: 200 μA) and cheap camera (Nikon D850, AF-S Micro-Nikkor 105 mm f/2.8G IF-ED).

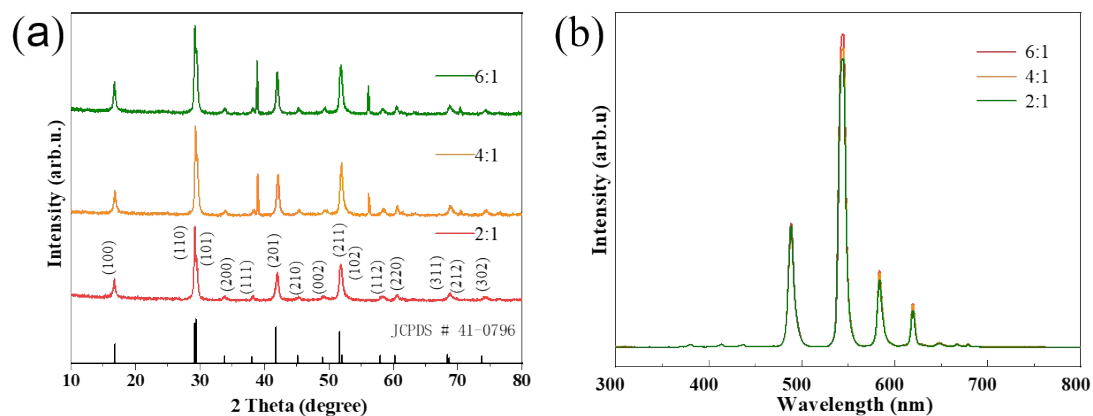


Figure S1. (a) XEOL spectra of the NaBiF₄:Tb NSs with different Tb³⁺ doping concentrations (5, 10, 15, 20 mol%) and (b) the corresponding integral intensity variations.

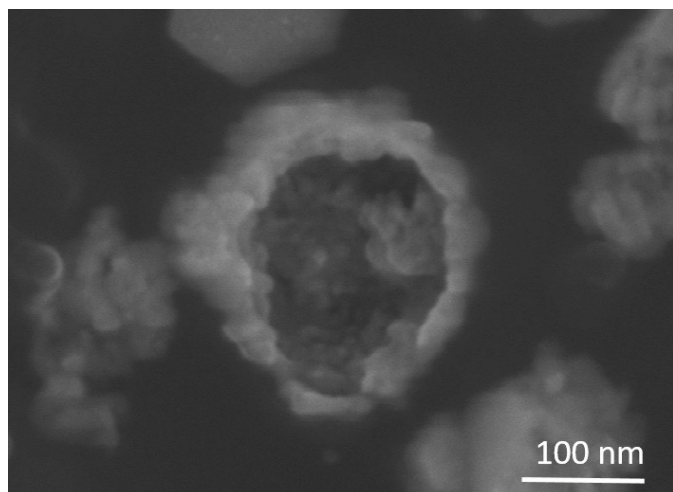


Figure S2. SEM image of the NaBiF₄:15Tb NSs.

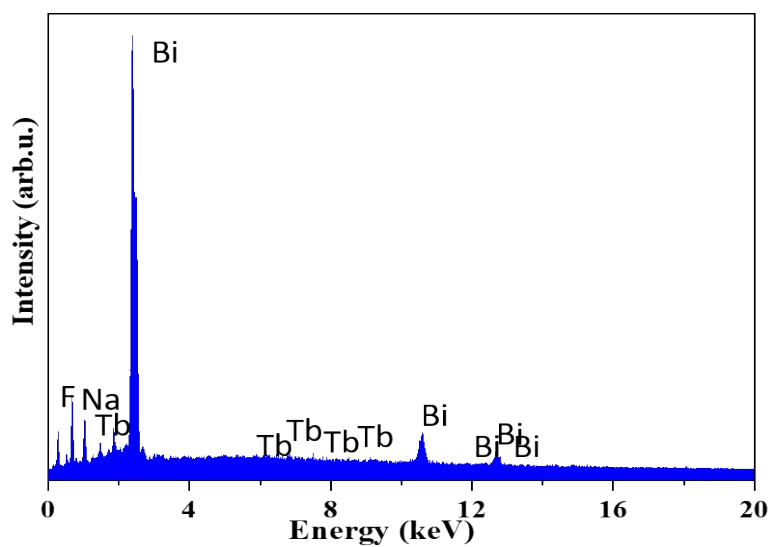


Figure S3. EDS spectra of the NaBiF₄:15Tb NSs.

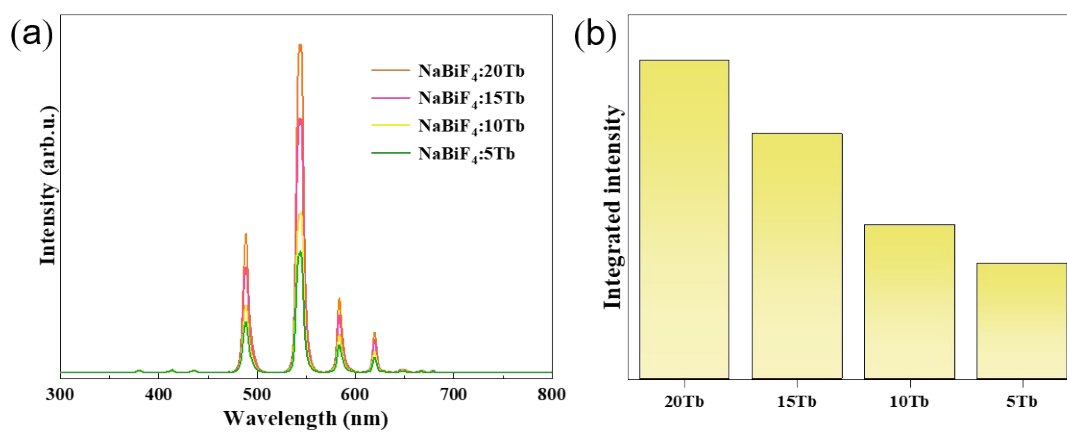


Figure S4. (a) XEOL spectra of the NaBiF₄:Tb NSs with different Tb³⁺ doping concentrations (5, 10, 15, 20 mol%) and (b) the corresponding integral intensity variations.

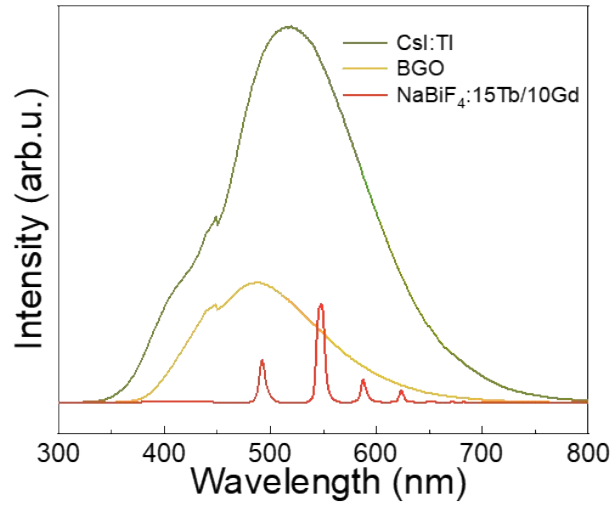


Figure S5. XEOL spectra of the NaBiF₄:15Tb/10Gd NSs, commercial BGO and CsI: TI.

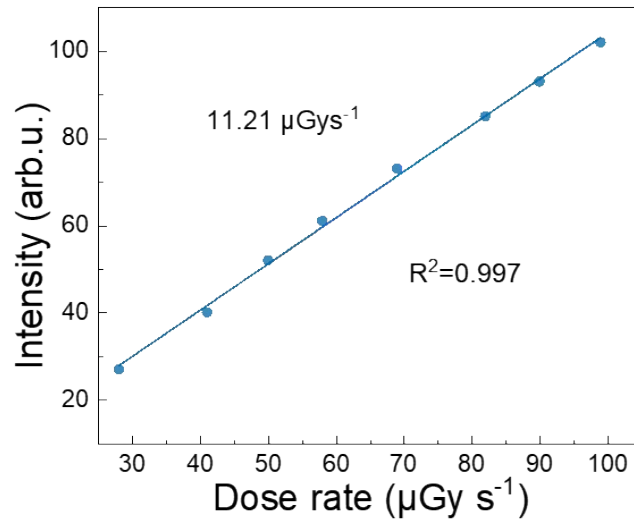


Figure S6. XEOL intensity of the NaBiF₄:15Tb/10Gd NSs measured at low-dose rates. The detection limit is derived from the fitting curve when the SNR equals 3.

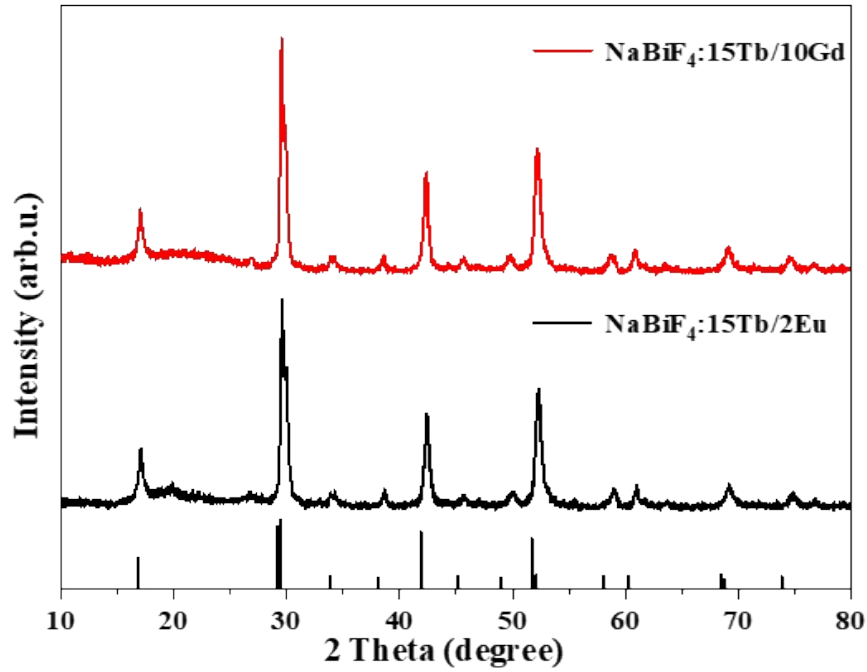


Figure S7. XRD pattern of the NaBiF₄:15Tb/10Gd, NaBiF₄:15Tb/2Eu NSs.

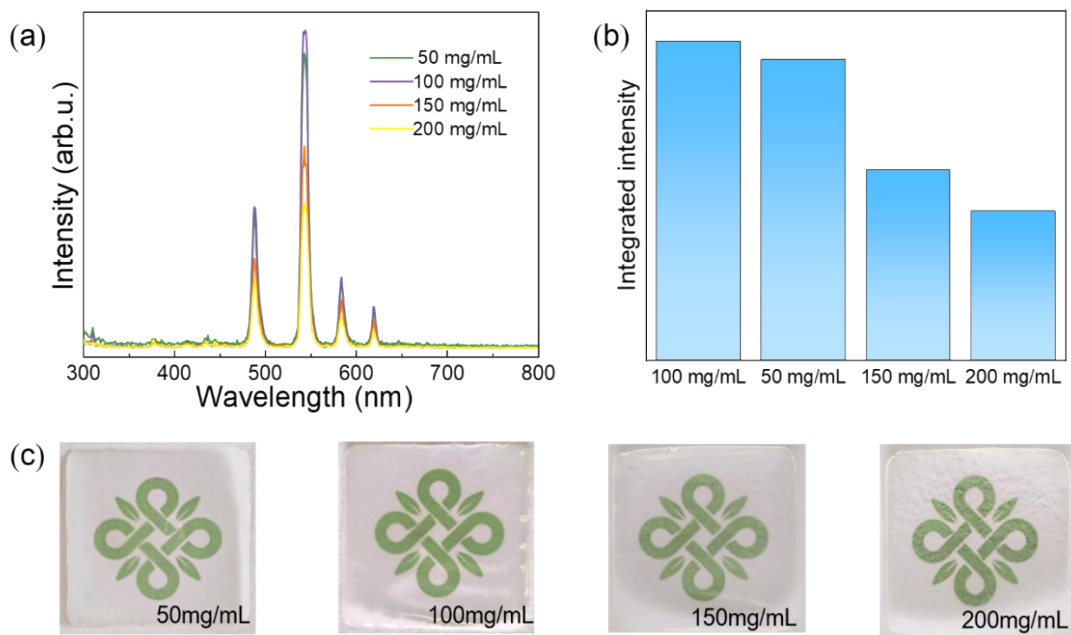


Figure S8. (a) XEOL diagram of the film after PMMA concentration regulation, and (b) the corresponding integral intensity variations. (c) Photographs of films doped with different PMMA concentrations.

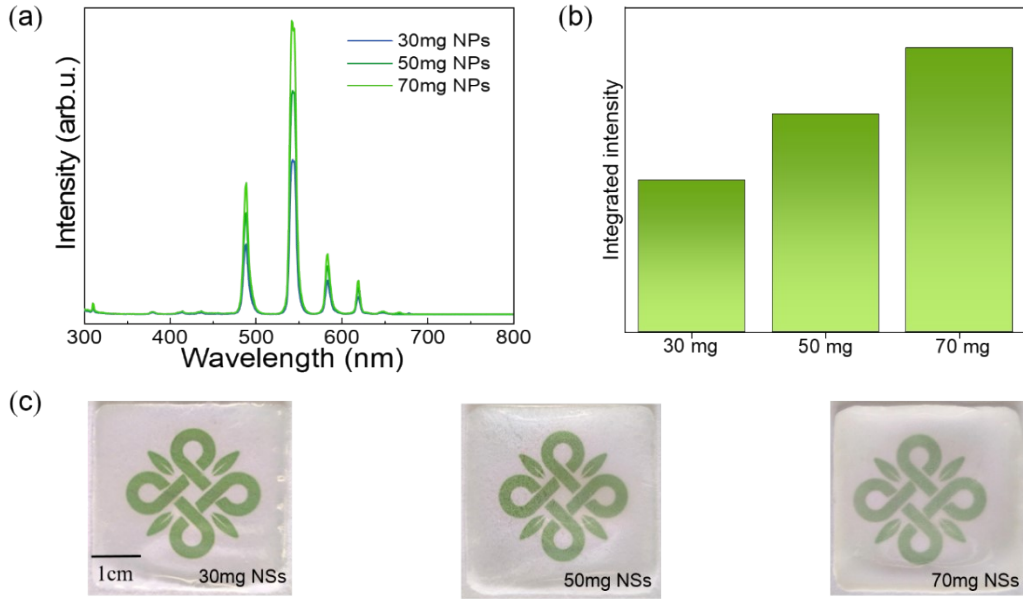


Figure S9. (a) XEOL diagram of the film with fixed PMMA concentration regulating the doping amount of NSs, and (b) the corresponding integral intensity variations. (c) Photographs of films doped with different NSs.

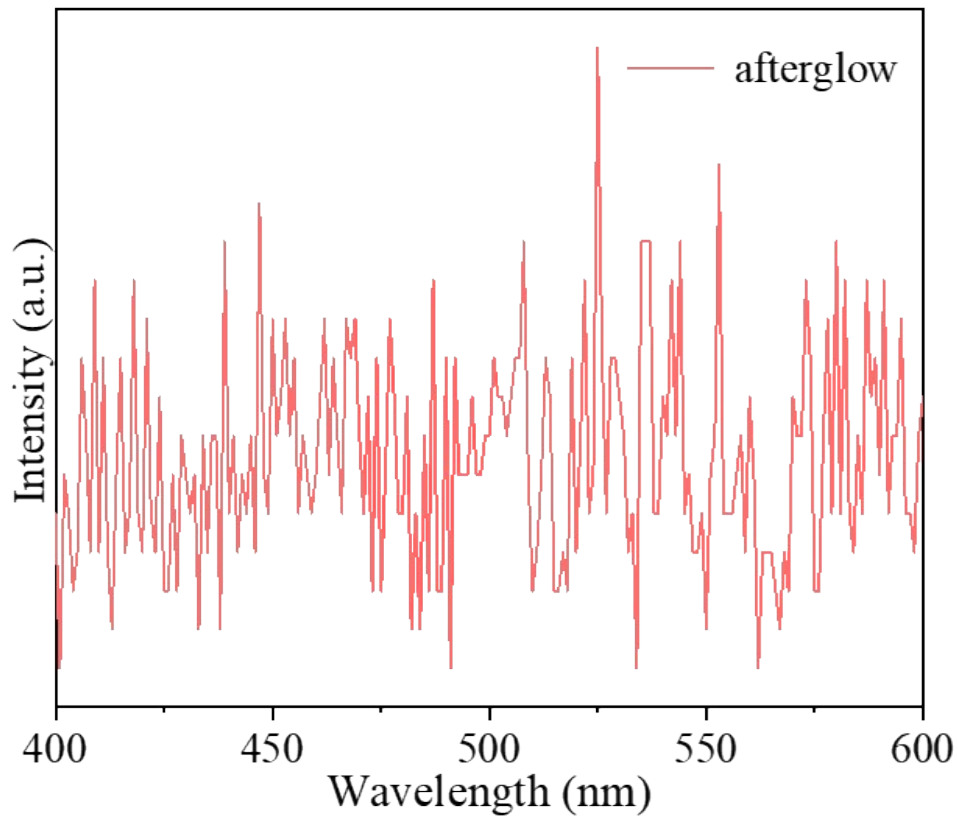


Figure S10. Afterglow spectrum of the NaBiF₄:15Tb/10Gd NSs (12 W, 20 mins).

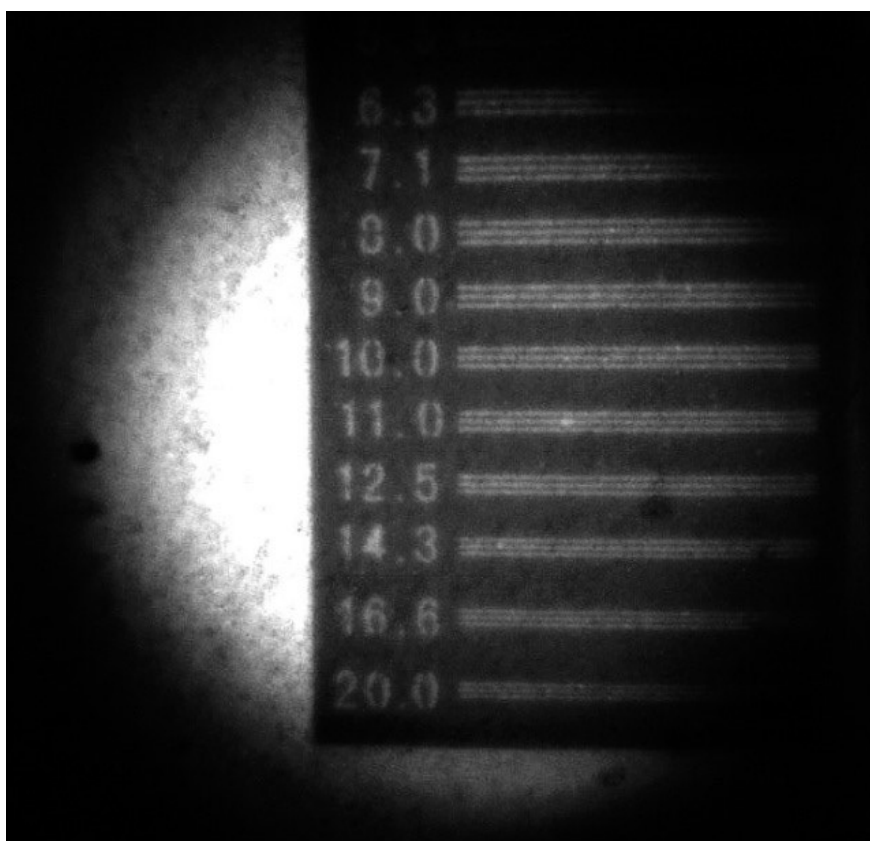


Figure S11. XEOL image of the standard X-ray resolution test pattern plate.