Supplementary Information (SI) for Inorganic Chemistry Frontiers.
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Supporting Information

X-ray Imaging and Storage Based on NaF Modified $Y_3Al_2Ga_3O_{12}$: Ce Phosphors

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Experimental section

Chemicals and Materials: Y_2O_3 (99.99%), Ga_2O_3 (99.99%), Al_2O_3 (≥99.99%), CeO_2 (≥99.99%), NaF (99.99%), were purchased from Aladdin. PDMS were purchased from Dow Corning. All the chemical reagents were used as received without further purification.

Synthesis of $Y_3Al_xGa_{(5-x)}O_{12}$: Ce: A series of $Y_3Al_xGa_{(5-x)}O_{12}$:Ce were prepared by a molten-salt method. The molar feeding ratio of NaF:Y2O3:Al2O3:Ga2O3:CeO2=2:3/2:X/2:(5-X)/2:0.025. Stoichiometric amounts of the aforementioned materials were placed in an agate mortar and ground with a small amount of absolute ethanol until the mixture was completely dry. After that, the mixture was placed into alumina crucibles and heated at 1300°C for 2.5 h in Hydrogen-nitrogen reducing atmosphere. After sintering, the products were cooled down to room temperature and ground again for the following analysis.

Synthesis of $Y_3Al_2Ga_3O_{12}$: Ce Films: Initially, 1 g of PDMS, 0.1 g of the curing agent and 0.5 g of $Y_3Al_2Ga_3O_{12}$:Ce powder was finely mixed in a vessel. Subsequently, the mixture was scraped onto the glass substrate. Finally, the film was obtained after curing at 70°C for 2 h.

Characterizations: X-ray diffraction (XRD) analysis was carried out by a powder diffractometer (Bruker D8 Advance) with a Cu-Kα (λ = 1.5405 Å) radiation. The morphology and size of the products were characterized by a S-3400 scanning electron microscopy (SEM) equipped with an energy dispersive X-ray spectroscopy (EDS, Aztec X-Max 80T). XEOL spectra and XEPerL decay curve were measured by a spectrometer (OmniFluo960) with an X-ray tube (target material: W, voltage 30 kV, tube current 200 μA) and a photon counter (DCS210PC-9S). X-ray imaging was performed using a home-made setup comprising a miniature X-ray tube and camera (ORCA-Fusion BT, C15440-20UP).

Table S1 The melting points of start materials.

Materials	Melting points (°C)
Y_2O_3	2410
Al_2O_3	2054
Ga_2O_3	1900
NaF	993

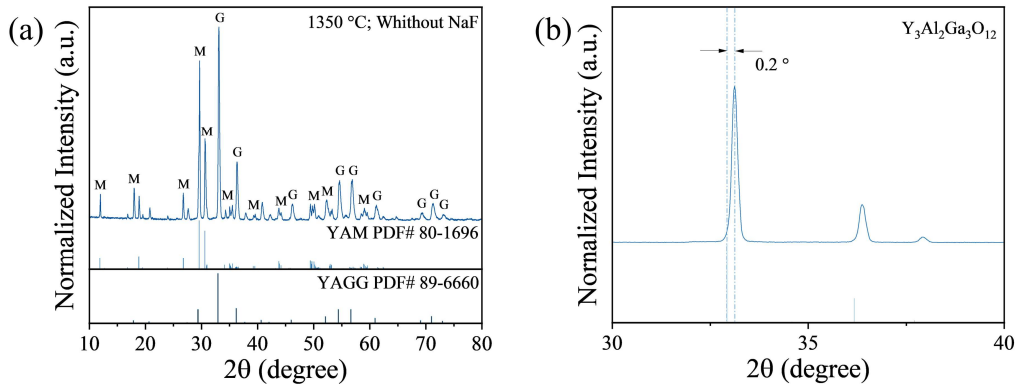

Figure S1 (a) XRD patterns of $Y_3Al_2Ga_3O_{12}$:Ce without NaF. (b) Zoom-in XRD patterns of NaF incorporated $Y_3Al_2Ga_3O_{12}$.

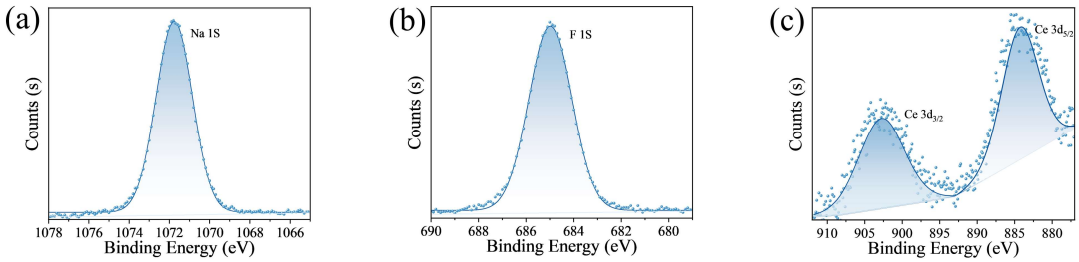

Figure S2 (a) XPS level spectra of Na 1s. (b) XPS level spectra of F 1s. (c) XPS level spectra of Ce 3d.

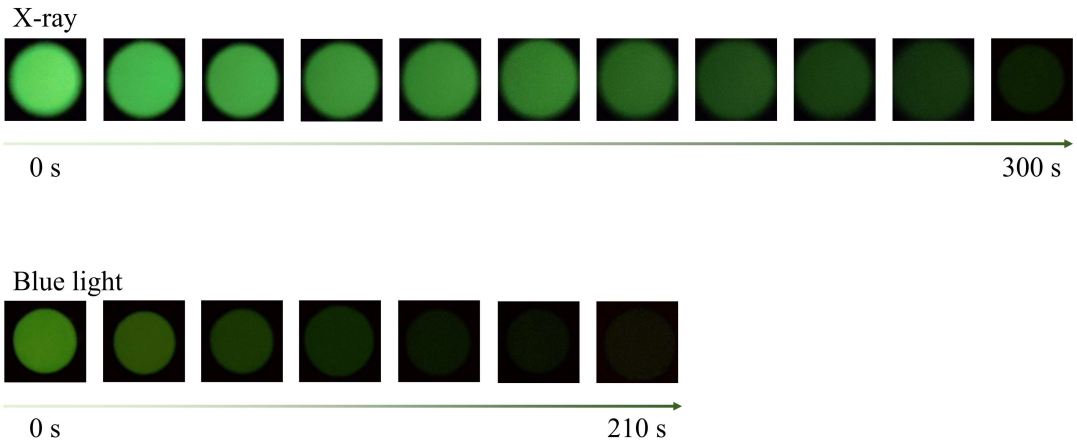

Figure S3. Afterglow images after X-ray and blue light excitation at various times.

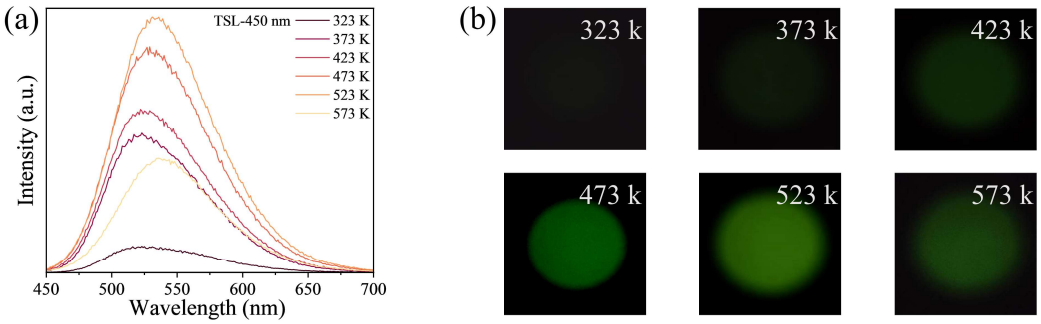

Figure S4 (a) TSL spectra of $Y_3Al_2Ga_3O_{12}$:Ce after 450nm excitation. (b) Persistent luminescence image of $Y_3Al_2Ga_3O_{12}$:Ce after 450 nm blue light excitation.

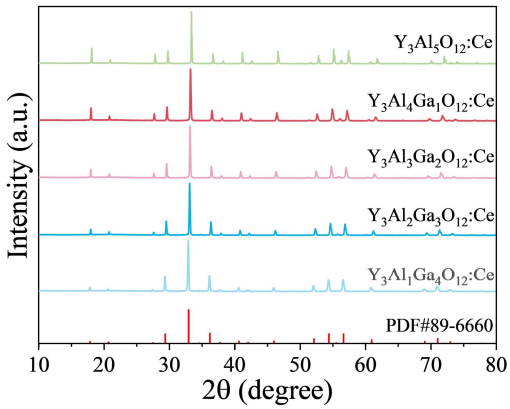

Figure S5 XRD patterns of $Y_3Al_xGa_{(5-x)}O_{12}$:Ce(x=1-5) compared with the standard card (PDF # 89-6660).

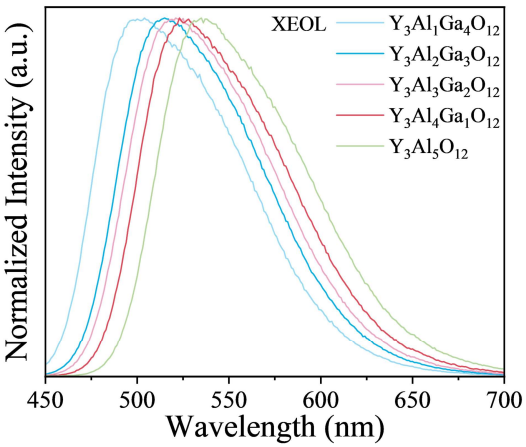

Figure S6 Normalized XEOL spectra of $Y_3Al_xGa_{(5-x)}O_{12}$:Ce(x=1-5).

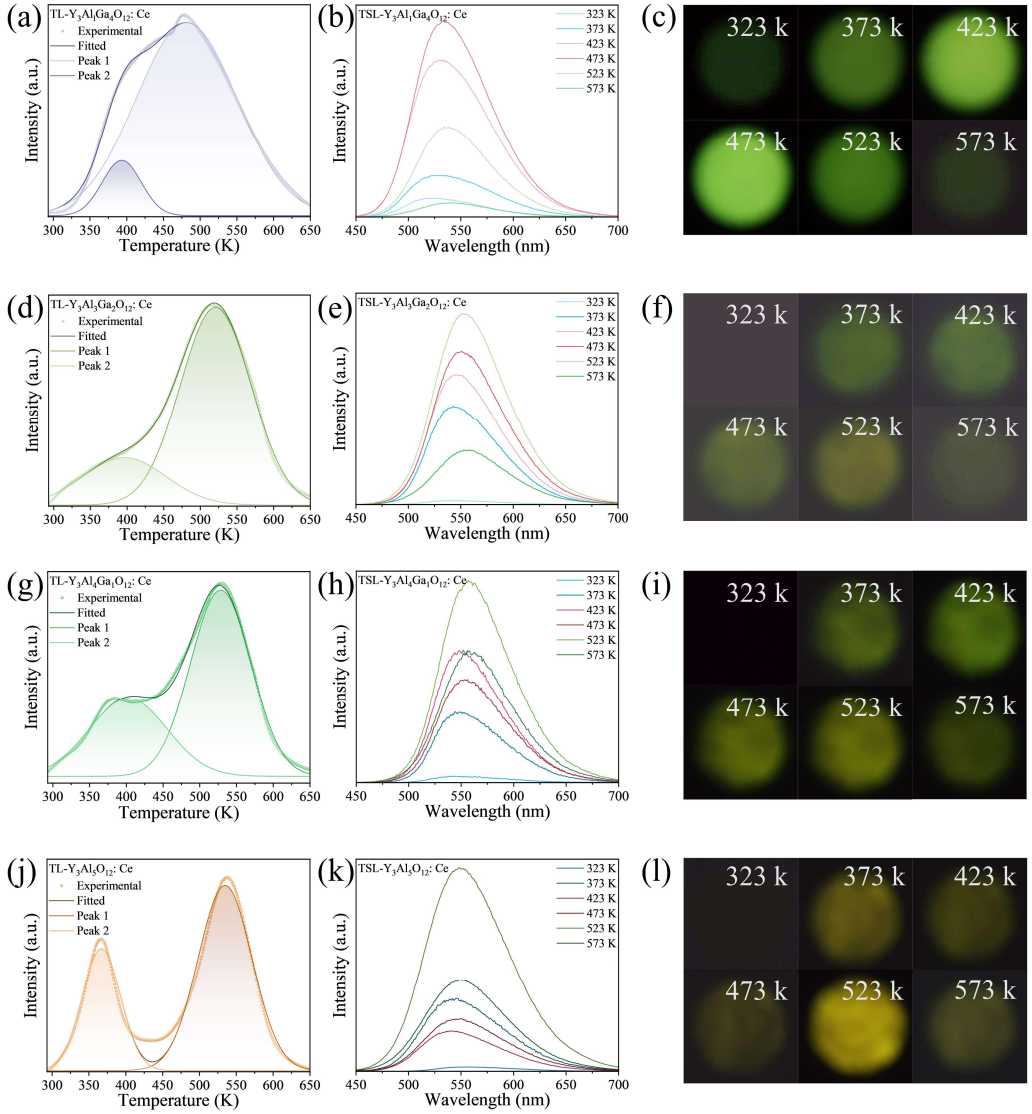

Figure S7 TL curves of $Y_3Al_1Ga_4O_{12}$:Ce (a), $Y_3Al_3Ga_2O_{12}$:Ce (d), $Y_3Al4Ga1O_{12}$:Ce (g) and $Y_3Al_5O_{12}$:Ce (j) under X-ray excitation. TSL spectra of $Y_3Al_1Ga_4O_{12}$:Ce (b), $Y_3Al_3Ga_2O_{12}$:Ce (e), $Y_3Al_4Ga_1O_{12}$:Ce (h), $Y_3Al_5O_{12}$:Ce (k) after X-ray excitation and corresponding luminescence images.

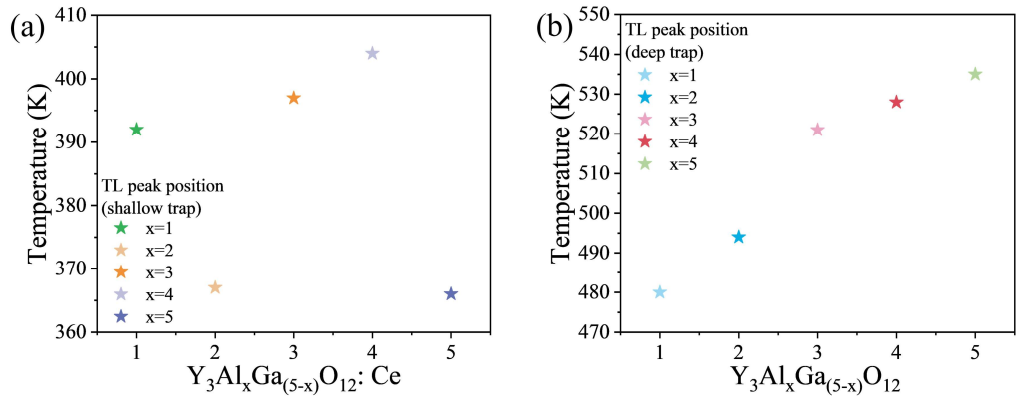

Figure S8 (a) Shallow trap depth variations of samples with different Al:Ga ratios. (b) Deep trap depth variations of samples with different Al:Ga ratios.

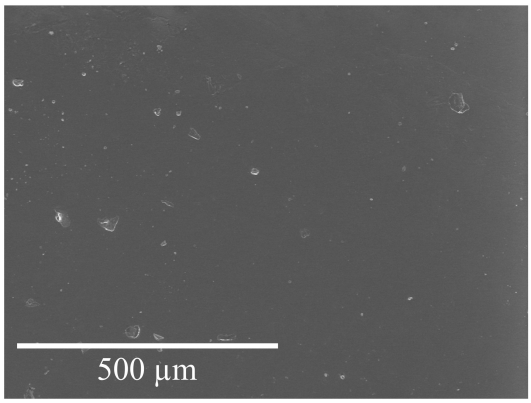

Figure S9 SEM image of $Y_3Al_2Ga_3O_{12}$:Ce@PDMS thin film.

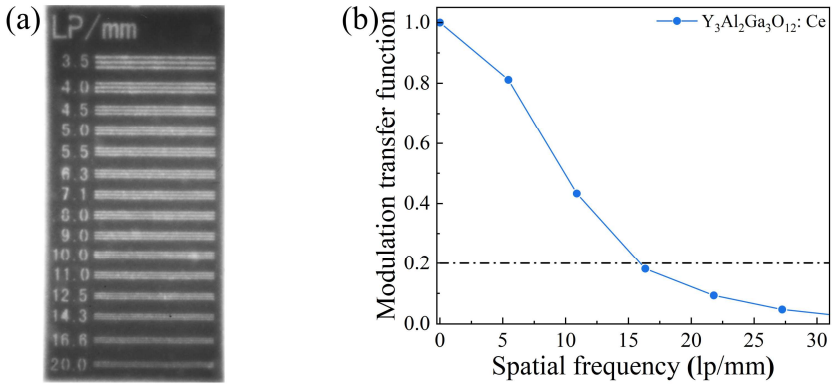

Figure S10 (a) XEOL image of the standard X-ray resolution test pattern plate for $Y_3Al_2Ga_3O_{12}$:Ce film. (b) MTF curve of the real-time X-ray image obtained from the $Y_3Al_2Ga_3O_{12}$:Ce film.

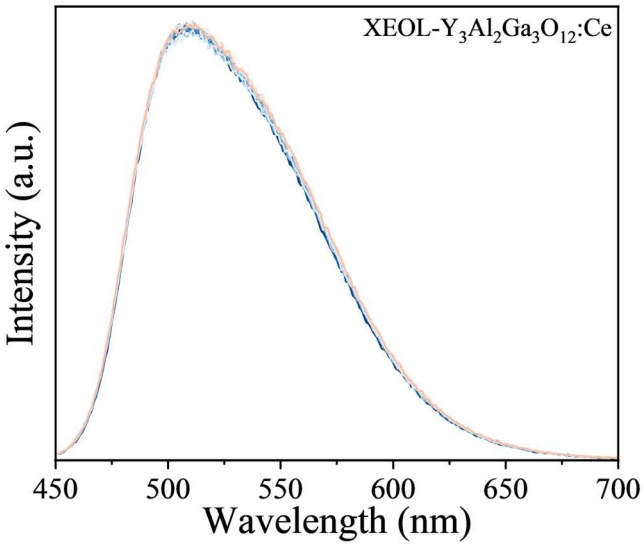

Figure S11. Repeated XEOL tests of $Y_3Al_2Ga_3O_{12}$:Ce@PDMS films.

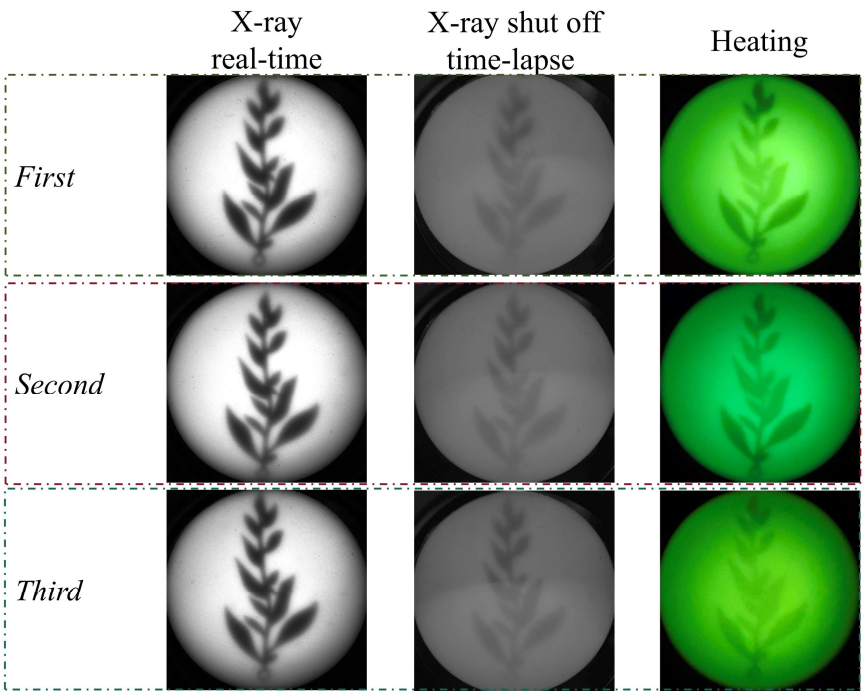

Figure S12. Repeated X-ray imaging application of $Y_3Al_2Ga_3O_{12}$:Ce@PDMS films.