Low-temperature synthesis of NaRE(WO$_4$)$_2$ films via sacrificial conversion from the layered rare-earth hydroxides, phase/morphology evolution, and photoluminescence

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**Fig. S1** XRD patterns (a) and FT-IR spectra (b) of NaLa(WO₄)₂ films obtained via further heat treatment at 150 °C, 300 °C, and 500 °C.

**Fig. S2** XRD patterns of anion exchanged films prepared with different concentration of Na₂WO₄ solutions at 100 °C.
**Fig. S3** XRD patterns of anion exchanged films synthesized prepared with 1.5M Na$_2$WO$_4$ solutions at different temperatures.

**Fig. S4** SEM morphologies of anion exchanged films synthesized prepared with 1.5M Na$_2$WO$_4$ solutions at different temperatures.
**Fig. S5** XRD patterns of the NaRE(WO$_4$)$_2$ (RE=Tb, Dy, Ho and Y) films prepared with 2M Na$_2$WO$_4$ solution at 100 °C for 6h.

**Fig. S6** FE-SEM images of the NaRE(WO$_4$)$_2$ (RE=Tb, Dy, Ho and Y) films prepared with 2M Na$_2$WO$_4$ solution at 100 °C for 6h.