

Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Screen Printing of Multi-mode Emissions NaYF₄:Yb,Er(Tm)/NaYF₄:Ce,Mn Composite for Anti-counterfeiting Applications

Wenjing Liu^a, Wenjun Zhang^a, Ruxin Liu^a, Guojing Li^a*

^a School of Chemical Engineering, Hebei University of Technology
Tianjin, 300130, China.

* E-mail: wjzhang@hebut.edu.cn

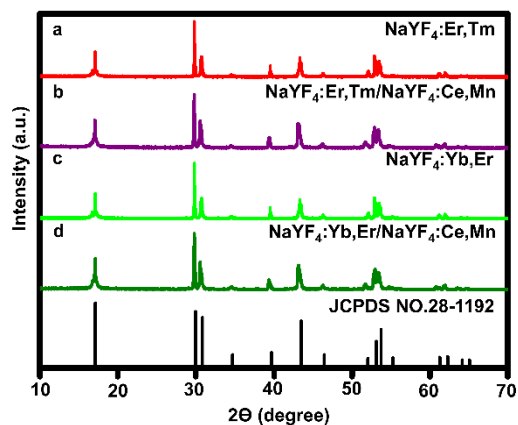


Fig. S1 XRD patterns of (a) $\text{NaYF}_4:\text{Er,Tm}$, (b) $\text{NaYF}_4:\text{Er,Tm}/\text{NaYF}_4:\text{Ce,Mn}$, (c) $\text{NaYF}_4:\text{Yb,Er}$, (d) $\text{NaYF}_4:\text{Yb,Er}/\text{NaYF}_4:\text{Ce,Mn}$ and the standard data of hexagonal phase NaYF_4 (JCPDS NO.28-1192).

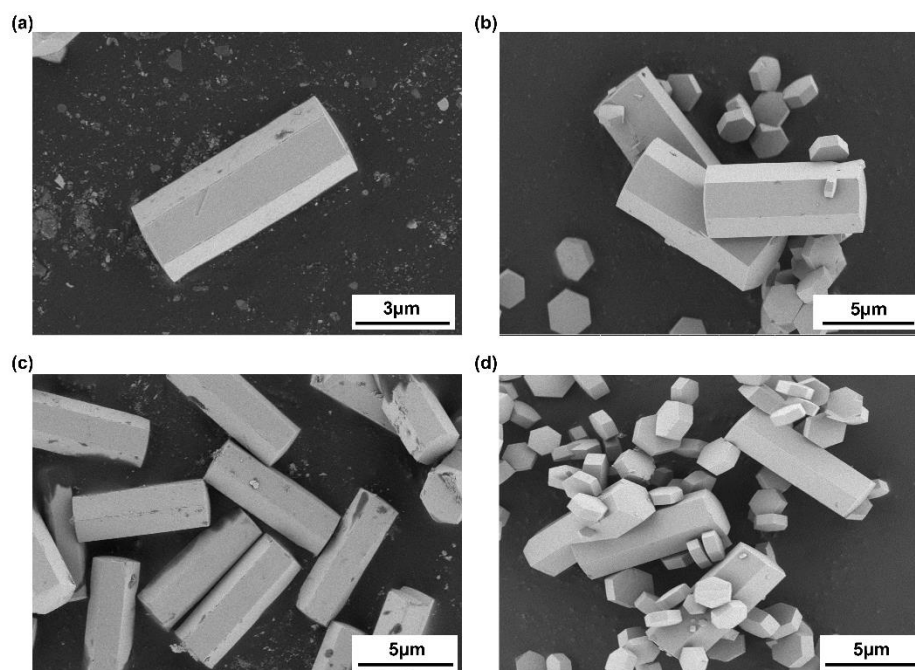


Fig. S2 The SEM images of (a) $\text{NaYF}_4:\text{Er,Tm}$, (b) $\text{NaYF}_4:\text{Er,Tm}/\text{NaYF}_4:\text{Ce,Mn}$, (c) $\text{NaYF}_4:\text{Yb,Er}$ and (d) $\text{NaYF}_4:\text{Yb,Er}/\text{NaYF}_4:\text{Ce,Mn}$.

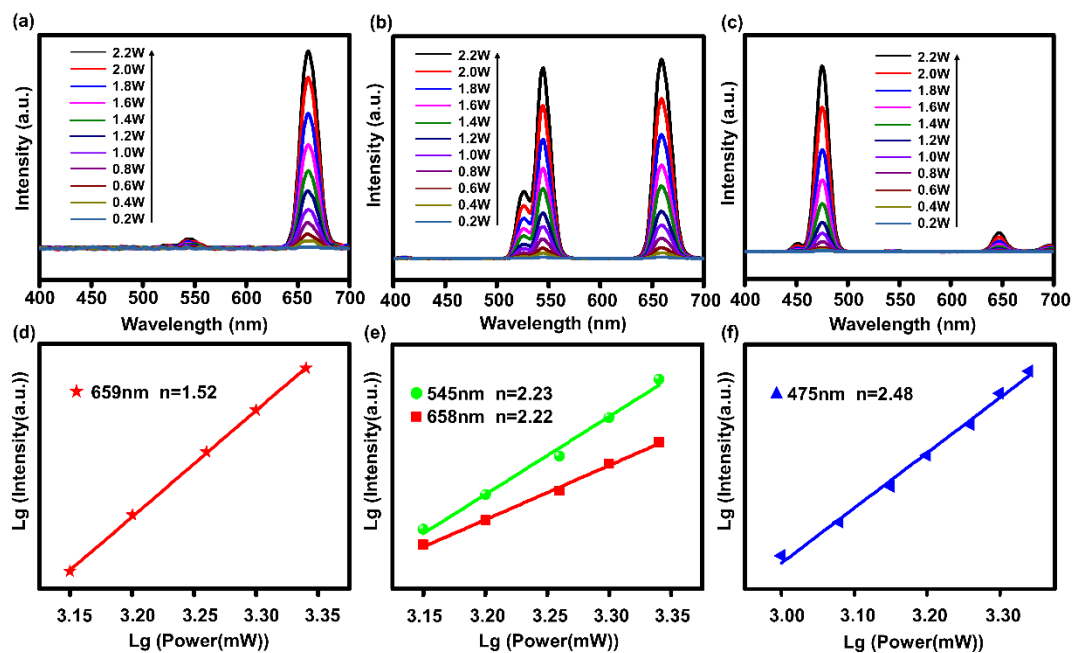


Fig. S3 The UC emission spectra excited by different laser power of (a) NaYF₄:Er,Tm, (b) NaYF₄:Yb,Er, (c) NaYF₄:Yb,Tm. Power dependence of UC emissions in (d) NaYF₄:Er,Tm, (e) NaYF₄:Yb,Er, (f) NaYF₄:Yb,Tm under the irradiation of 980 nm lasers.

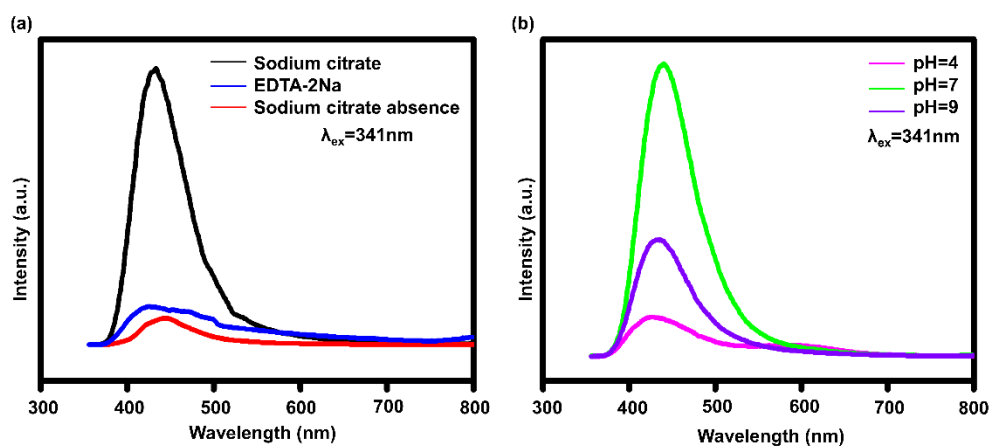


Fig. S4 The emission spectrum of NaYF₄:Yb,Tm/NaYF₄:Ce,Mn was obtained at 341 nm (a) using different chelating agents, (b) under different pH.

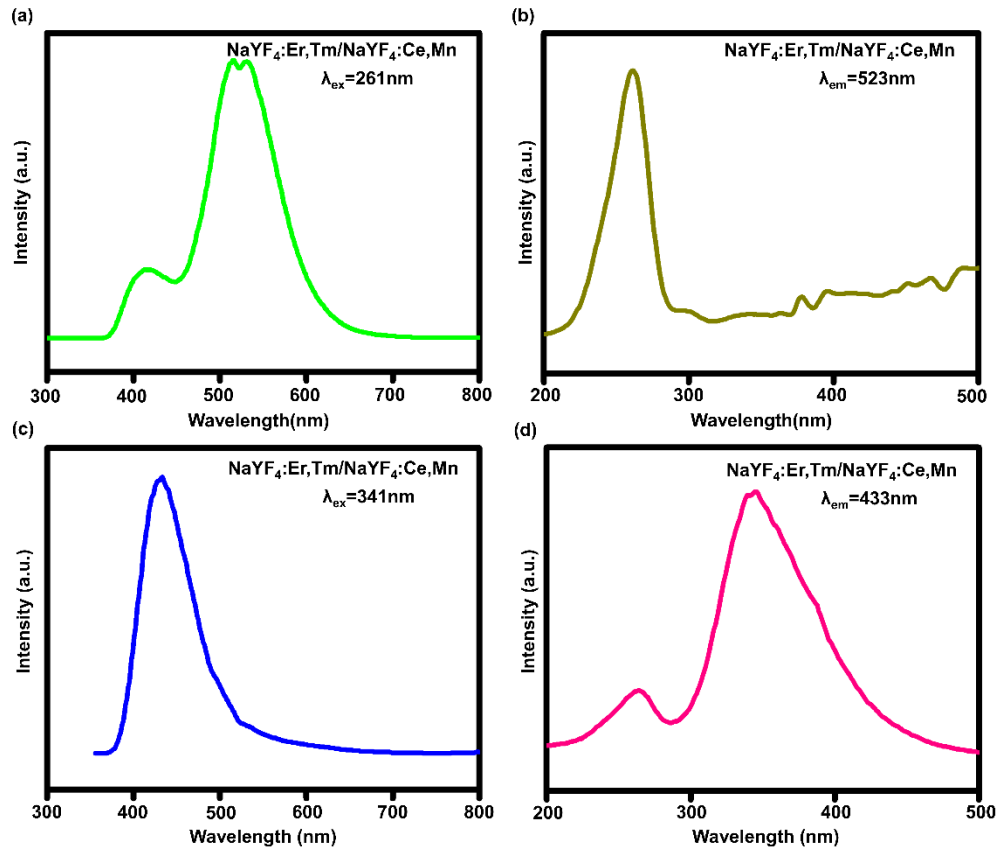


Fig. S5 The emission and excitation spectrum of $\text{NaYF}_4:\text{Er,Tm}/\text{NaYF}_4:\text{Ce,Mn}$ at different wavelengths. (a) The emission spectrum was obtained at 261 nm. (b) The excitation spectrum was obtained at 523 nm. (c) The emission spectrum was obtained at 341 nm. (d) The excitation spectrum was obtained at 433 nm.

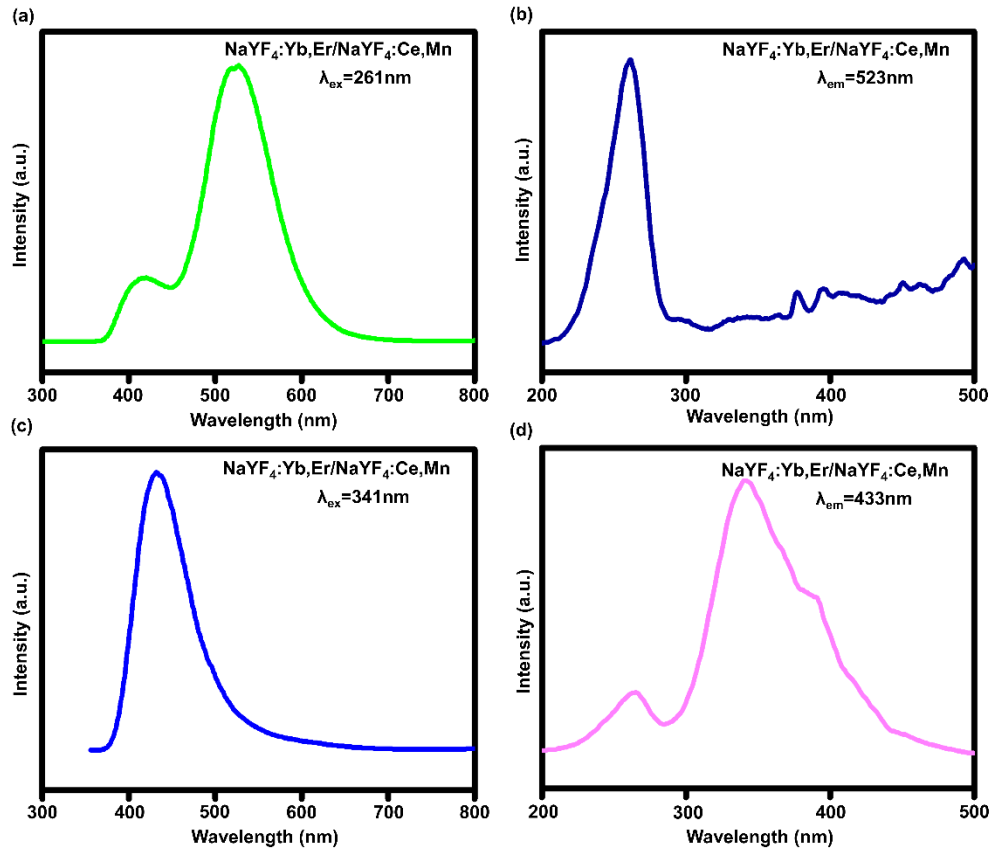


Fig. S6 The emission and excitation spectrum of $\text{NaYF}_4:\text{Yb,Er}/\text{NaYF}_4:\text{Ce,Mn}$ at different wavelengths. (a) The emission spectrum was obtained at 261 nm. (b) The excitation spectrum was obtained at 523 nm. (c) The emission spectrum was obtained at 341 nm. (d) The excitation spectrum was obtained at 433 nm.



Fig. S7 The image of screen printing plate.

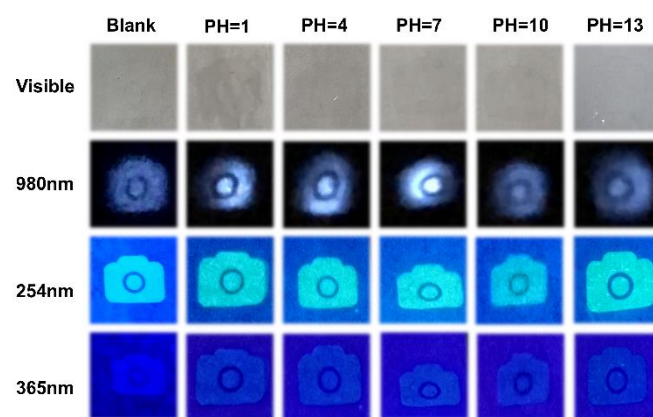


Fig. S8 Designable patterns of three kinds of inks under visible light, 980 nm light, 254 nm light and 365 nm light at different pH values.