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Emerging UCr_4C_4-type Narrow-band Silicate Phosphors for Backlight Display Application

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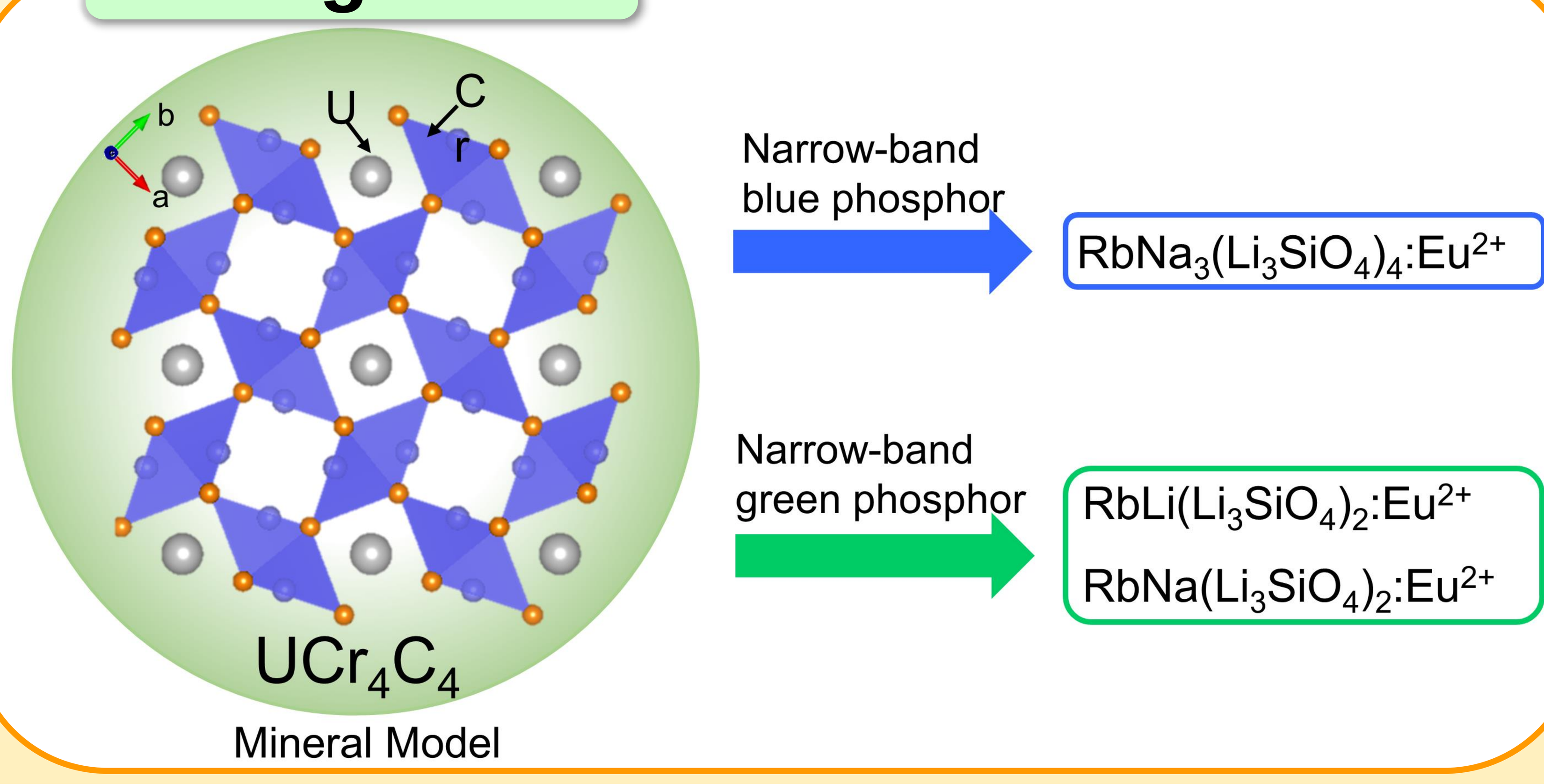
Background



$RbNa_3(Li_3SiO_4)_4:Eu^{2+}$

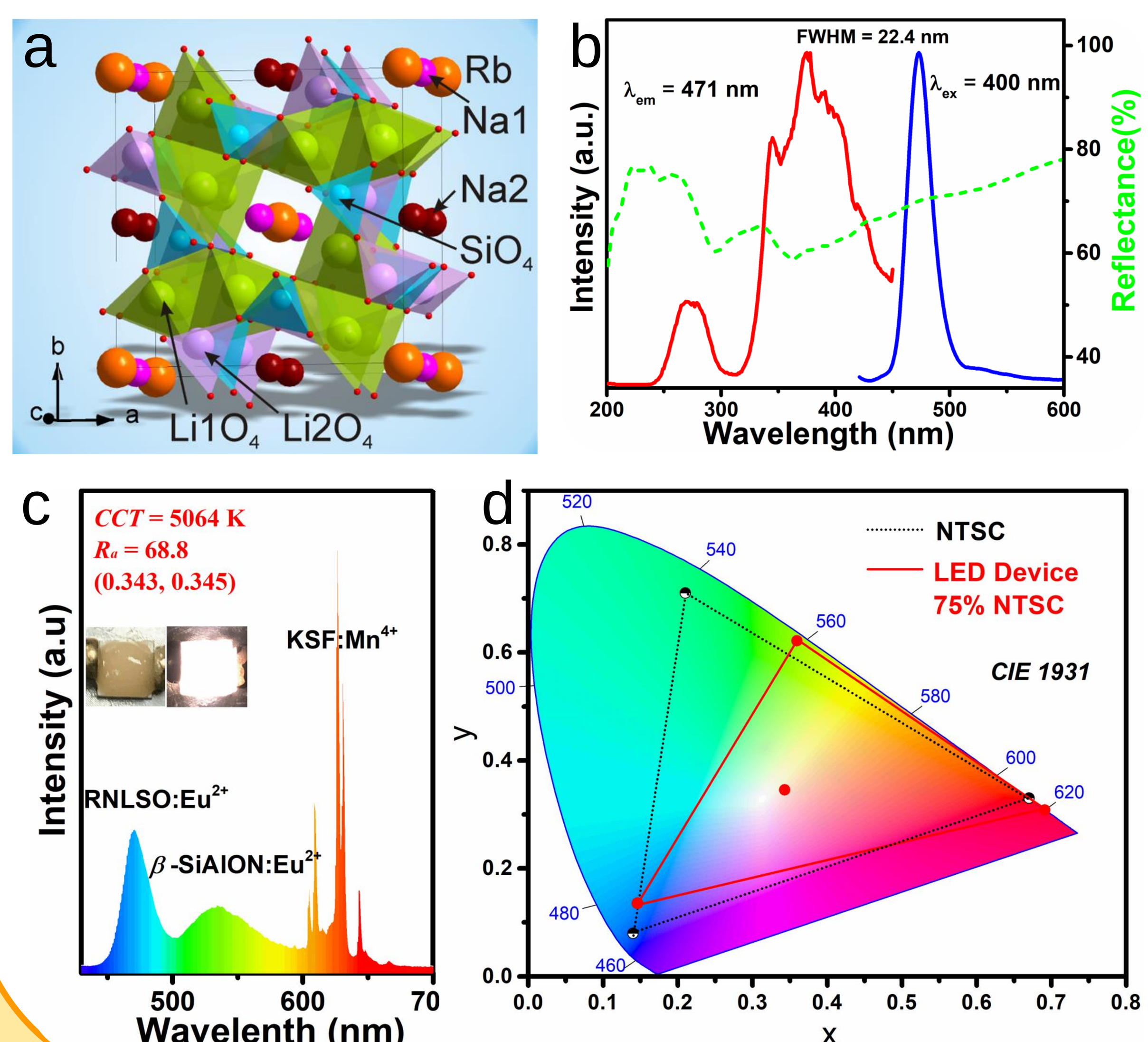


Fig. 1. (**a**) Crystal structure of $RbNa_3(Li_3SiO_4)_4$ (RNLSO). (b) PL, PLE and UV/vis spectra of RNLSO:Eu^{2+}. (**c**) Emission spectrum of the LED device. (**d**) CIE 1931 color coordinates of fabricated white LED, and color space of NTSC standard (short dotted line) and white LED device (red line).

$RbLi(Li_3SiO_4)_2:Eu^{2+}$

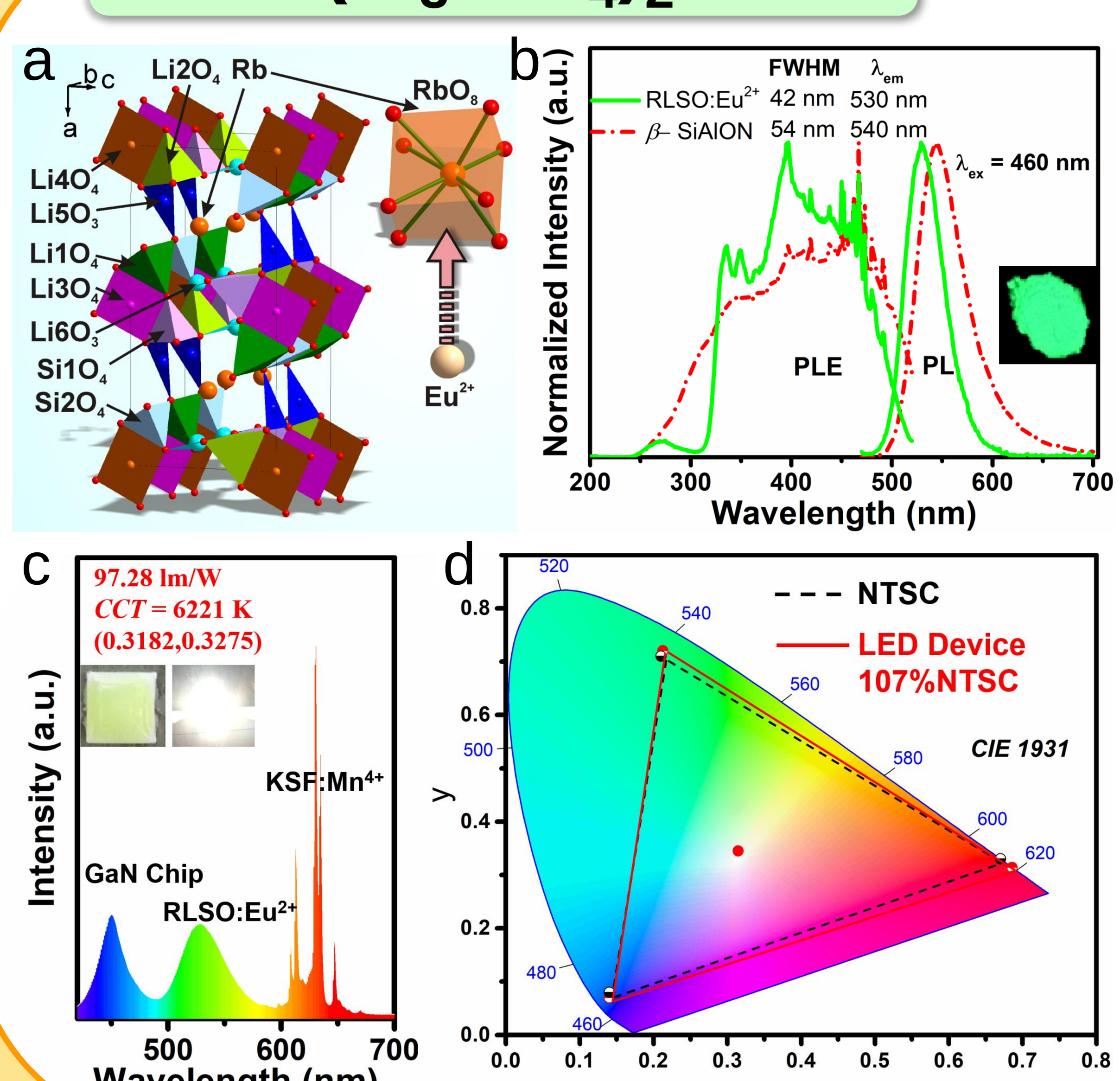


Fig. 2. (**a**) Crystal structure of $RbLi(Li_3SiO_4)_2$ (RLSO) . (**b**) PLE and PL spectra of RLSO:8%Eu^{2+} and the commercial β-SiAlON:Eu^{2+}. (**c**) Emission spectrum of the LED device. (**d**) CIE 1931 color coordinates of fabricated white LED, and color space of NTSC standard (black dotted line) and white LED device (red line).

$RbNa(Li_3SiO_4)_2:Eu^{2+}$

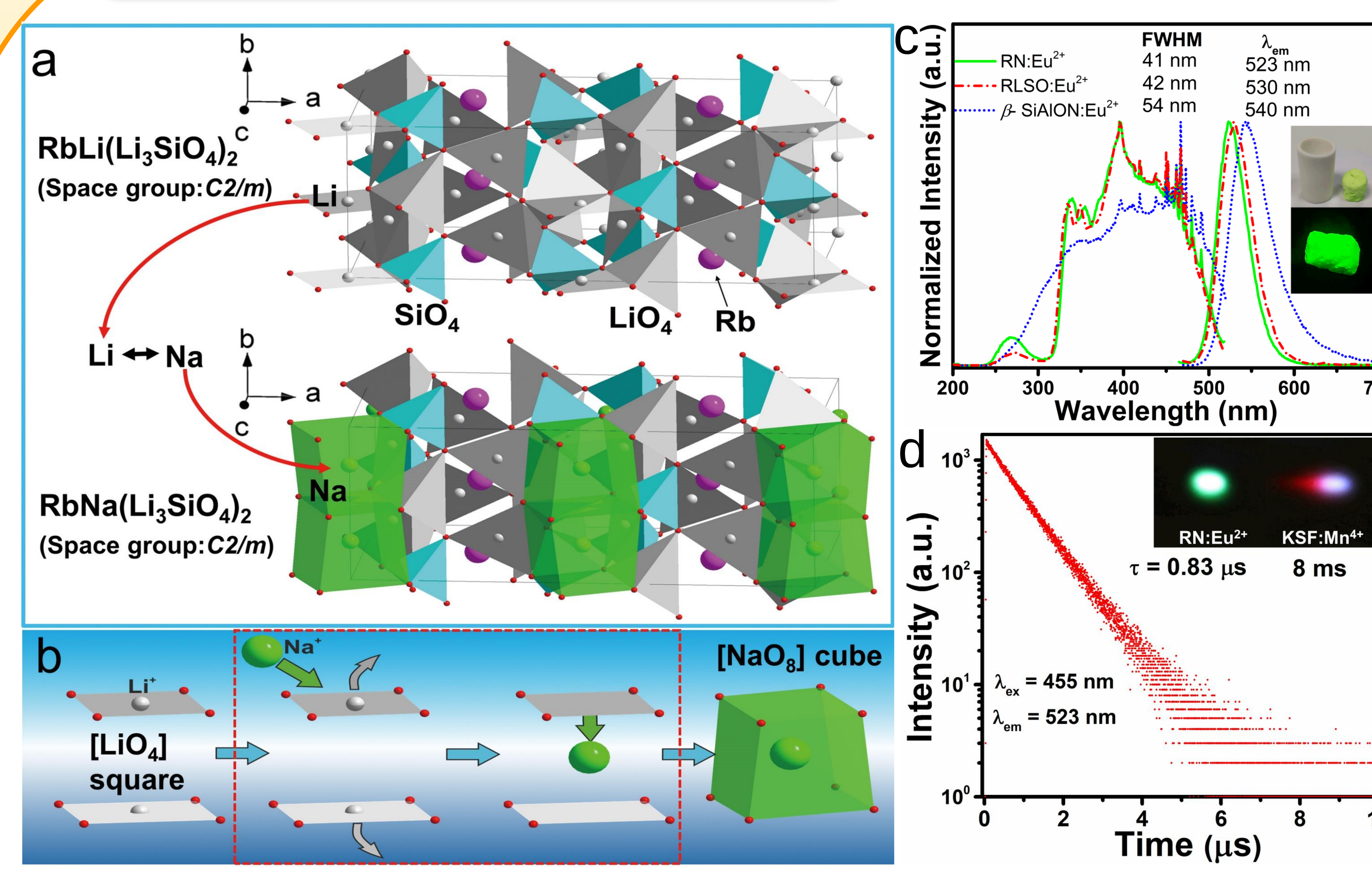


Fig. 3. (**a**) Comparison of the crystal structures of $RbLi(Li_3SiO_4)_2$ (RLSO) and $RbNa(Li_3SiO_4)_2$ (RN). (**b**) The proposed structural transformation mechanism demonstrating the formation of $[NaO_8]$ cube in RN compared to $[LiO_4]$ square in RLSO due to the bigger ion radii of Na^+ in comparison with Li^+. (**c**) PLE and PL spectra of RN:8%Eu^{2+}, RLSO:8%Eu^{2+} and β-SiAlON:Eu^{2+}. (**d**) The decay curve of RN:8%Eu^{2+}. The insets show the images of RN:Eu^{2+} and KSF:Mn^{4+} with the same mobile excitation source.

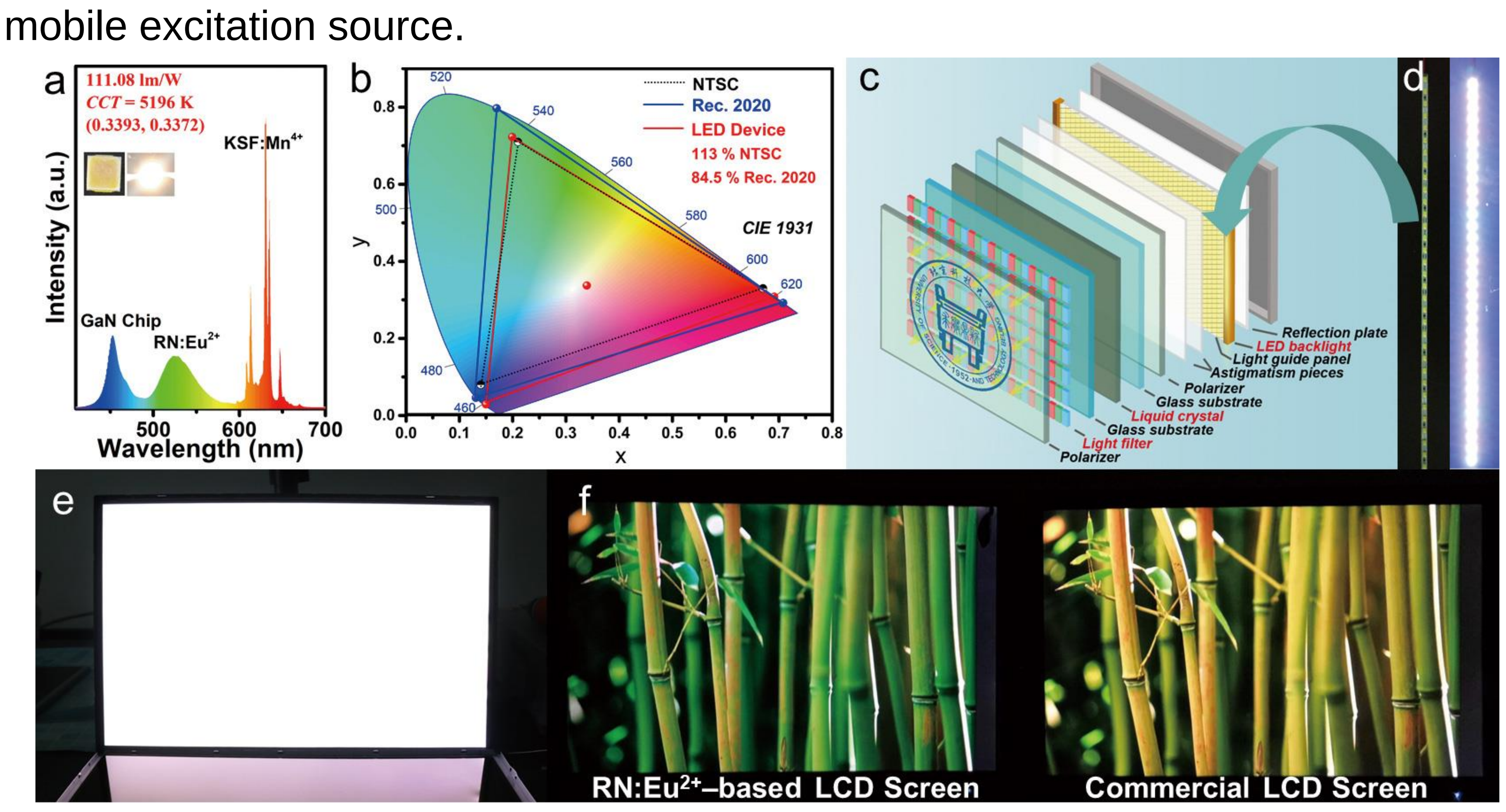


Fig. 4. (**a**) Emission spectrum of the WLED fabricated with the green phosphor RN:Eu^{2+}, red phosphor KSF:Mn^{4+}, and a blue LED chip. (**b**) CIE 1931 color coordinate of the fabricated WLED, color space of NTSC standard, Rec. 2020 and WLED. (**c**) Schematic diagram of the configuration of the LCD prototype based on the pc-LEDs technique. (**d**) The as-fabricated and lightened WLEDs backlight. (**e**) The backlight panel of the LCD. (**f**) Comparison of the display images of the RN:Eu^{2+}-based LCD screen and commercial LCD screen with the backlight fabricated by blue chips, yellow YAG:Ce, and red KSF:Mn^{4+} phosphors.

Conclusion

UCr_4C_4-type crystal structure plays an important role in the discovery of the narrow-band phosphors, owing to the highly condensed, rigid framework, and highly symmetric dopant sites of the structure. Hence, inspired by the discovery strategy of new LED phosphors via the mineral-inspired prototype evolution, we reported three narrow-band silicate phosphors derived from the UCr_4C_4-type mineral model for backlight display application. $RbNa_3(Li_3SiO_4)_4:Eu^{2+}$ presents an ultra narrow-band blue emission (λ_{em} = 471 nm, FWHM = 22.4 nm), $RbLi(Li_3SiO_4)_2:Eu^{2+}$ shows a surprising narrow-band green emission at 530 nm with FWHM of 42 nm, and $RbNa(Li_3SiO_4)_2$:Eu^{2+}nm also exhibits a narrow-band green emission (λ_{em} = 523 nm, FWHM = 41 nm), which have great application prospects in the liquid crystal display. These encouraging breakthroughs in narrow-band phosphors undoubtedly represent important steps toward emerging new materials from the prototype mineral structure, and this concept opens a gateway for discovering new narrow-emitting phosphors with multiple applications.

Reference

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