# Supporting Information

***Title*:**

Colorimetric Optical Thermometry of Host-Sensitized $Pr^{3+}$-Doped Niobate Phosphors based on Electronic-Rich-Site Strategy

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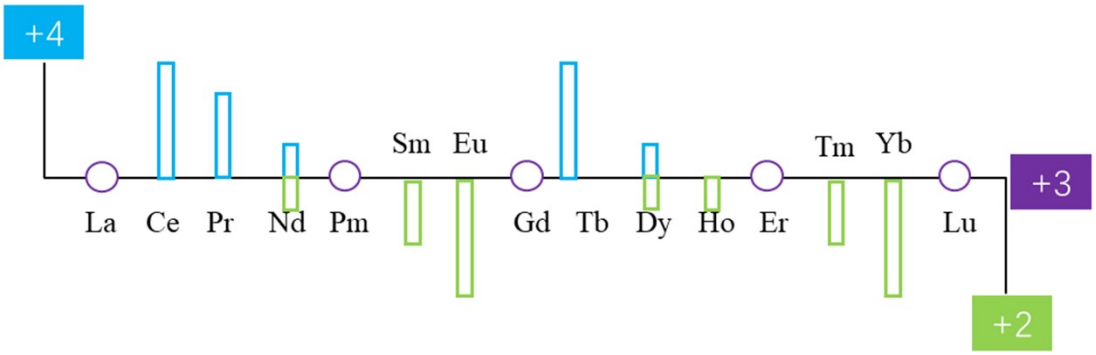


**Figure S1.** The valence state change diagram of lanthanides.

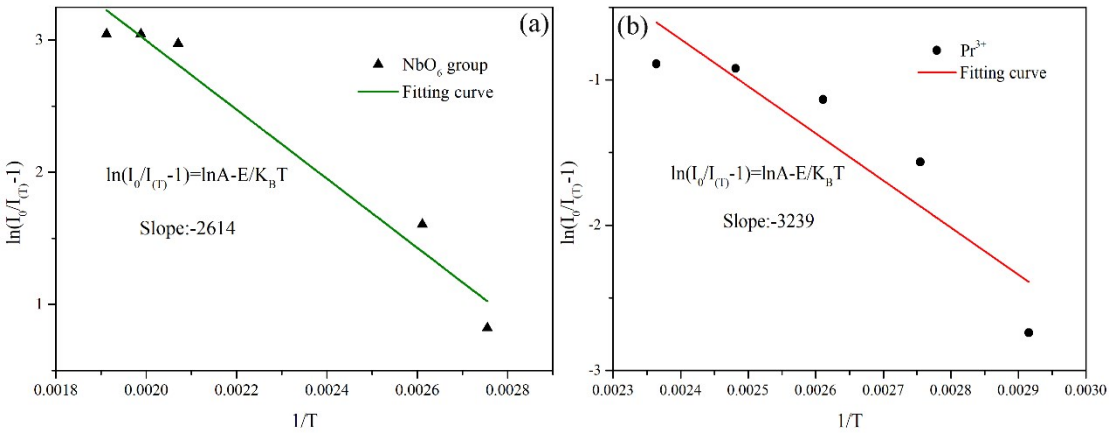


**Figure S2.** Thermal quenching activation energy fitting diagram of (a) $NbO_6$ group and (b) $Pr^{3+}$ ion.

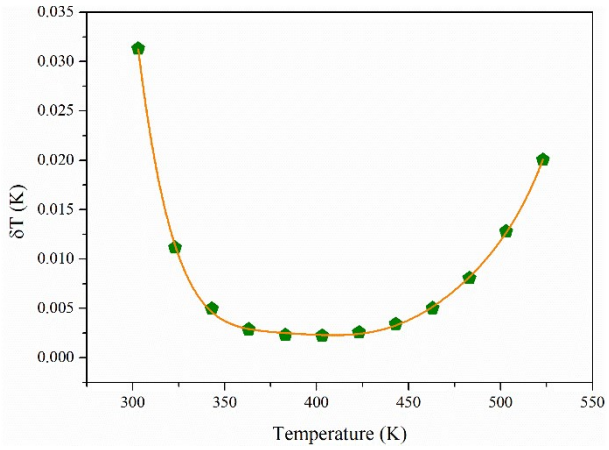


**Figure S3.** The temperature resolution of CNO:0.005$Pr^{3+}$ phosphors.

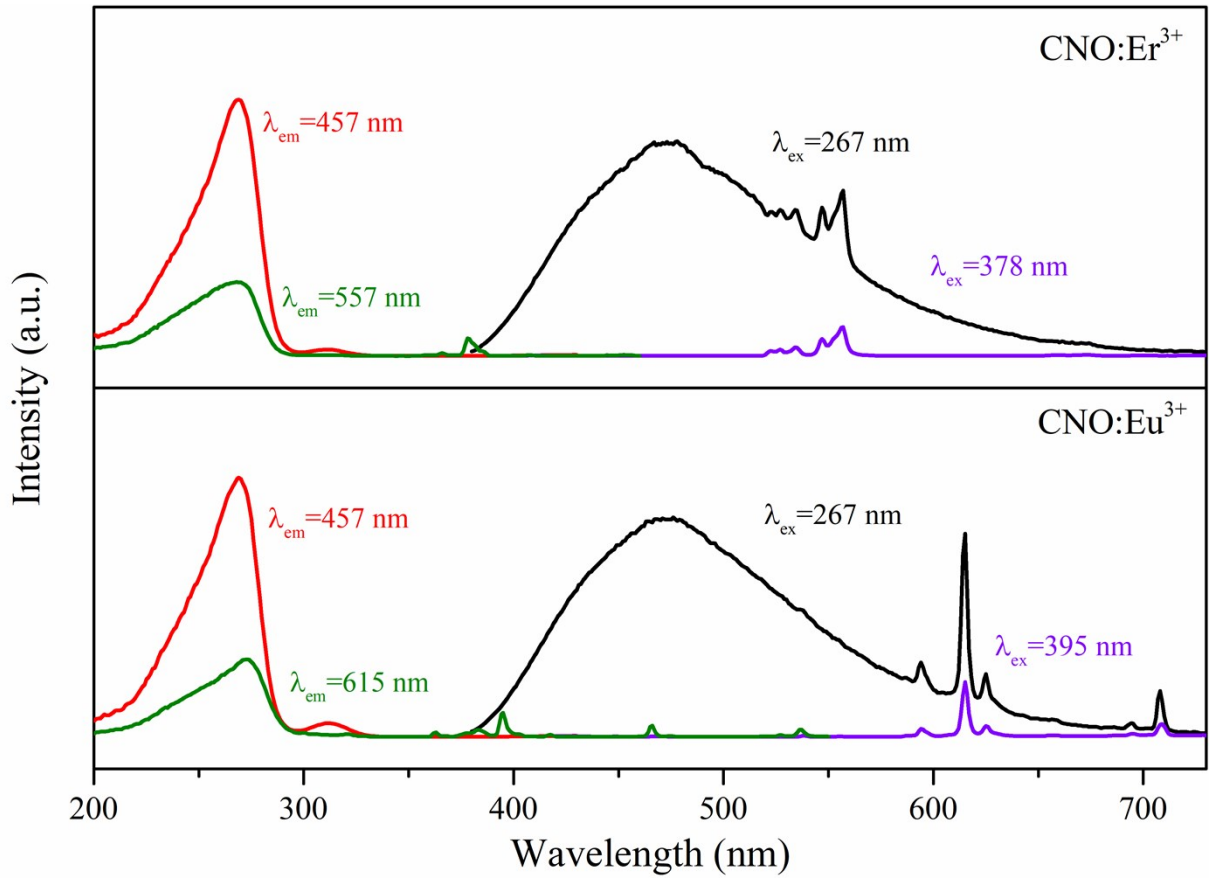


**Figure S4.** The PLE and PL spectra of (a) CNO:0.015$Er^{3+}$, and (b) CNO:0.005$Eu^{3+}$.

The excitation and emission spectra of CNO:0.015$Er^{3+}$ phosphor are shown in Figure S4(a). Setting the monitoring wavelength to 557 nm, we can see that there are broad excitation bands at 270 nm due to matrix absorption and 365 nm ($^4I_{15/2}\rightarrow{}^4G_{9/2}$), 378 nm ($^4I_{15/2}\rightarrow{}^4G_{11/2}$), The weak absorption bands at 404 nm ($^4I_{15/2}\rightarrow{}^2H_{9/2}$) and 452 nm ($^4I_{15/2}\rightarrow{}^4F_{5/2}$) are attributed to the 4f transition in $Er^{3+}$. Under 378 nm excitation, the emission peaks at 534 nm, 557 nm and 661 nm originated from the $Er^{3+}$ $^2H_{11/2}\rightarrow{}^4I_{14/2}$, $^4S_{3/2}\rightarrow{}^4I_{15/2}$ and $^4F_{9/2}\rightarrow{}^4I_{15/2}$ transitions, respectively. Figure S4(b) vividly depicts the fluorescence spectrum of single-doped $Eu^{3+}$ ion phosphor. Under the monitoring of the characteristic wavelength of $Eu^{3+}$ ion at 615 nm, the excitation peak at 274 nm is due to matrix absorption, and the remaining narrow peaks (363, 384, 396, 416, 465 and 538 nm) are due to the charge transfer of $Eu^{3+}\rightarrow O^{2-}$ and the 4f-4f transition of $Eu^{3+}$ ion. In the emission spectrum ($\lambda_{ex}$=395 nm), the four emission peaks in the range of 590-708 nm are attributed to the $^5D_0\rightarrow{}^7F_J$ (J=1-4) transition of $Eu^{3+}$.

**Table S1.** Correlated data for Crystallography and Refinement Results for CNO:$Ln^{3+}$ ($Ln^{3+}$ = $Pr^{3+}$/$Er^{3+}$/$Eu^{3+}$) Samples.

| Parameter | CNO standard crystal | CNO:0.01$Pr^{3+}$ | CNO:0.015$Er^{3+}$ | CNO:0.005$Eu^{3+}$ |
|---|---|---|---|---|
| Space group | Pbcn(60) | Pbcn(60) | Pbcn(60) | Pbcn(60) |
| a (Å) | 14.926 | 14.977 | 14.974 | 14.988 |
| b (Å) | 5.752 | 5.752 | 5.750 | 5.755 |
| c (Å) | 5.204 | 5.223 | 5.223 | 5.227 |
| α=β=γ (deg) | 90 | 90 | 90 | 90 |
| V ($Å^3$) | 446.79 | 449.91 | 449.70 | 450.87 |
| Units (Z) | 4 | 4 | 4 | 4 |
| $R_p$ % | | 6.58 | 5.03 | 4.60 |
| $R_{wp}$ % | | 9.02 | 7.00 | 6.44 |
| χ | | 4.05 | 2.88 | 2.86 |

**Table S2.** The absolute error and relative error of experimental data when the temperature rises and falls.

| Temperature/ K | FIR of rises | FIR of falls | Absolute error/K | Relative error/% |
|---|---|---|---|---|
| 303 | 0.03875 | 0.0384 | 0.00035 | 0.90% |
| 323 | 0.04235 | 0.04336 | 0.00101 | 2.38% |
| 343 | 0.04978 | 0.05103 | 0.00125 | 2.51% |
| 363 | 0.06559 | 0.06677 | 0.00118 | 1.80% |
| 383 | 0.10193 | 0.09514 | 0.00679 | 6.66% |
| 403 | 0.15909 | 0.1644 | 0.00531 | 3.34% |
| 423 | 0.24016 | 0.24378 | 0.00362 | 1.50% |
| 443 | 0.33476 | 0.33429 | 0.00047 | 0.14% |
| 463 | 0.42636 | 0.42506 | 0.0013 | 0.30% |
| 483 | 0.51417 | 0.50583 | 0.00834 | 1.62% |
| 503 | 0.5653 | 0.56106 | 0.00424 | 0.75% |
| 523 | 0.58736 | 0.5846 | 0.00276 | 0.47% |