

Systematic investigation of Eu^{3+} activated $\text{Na}_2\text{Ln}_4(\text{MoO}_4)_7$ [Ln = La, Gd and Y] narrow band red emitting phosphors for hybrid white LEDs and plant growth

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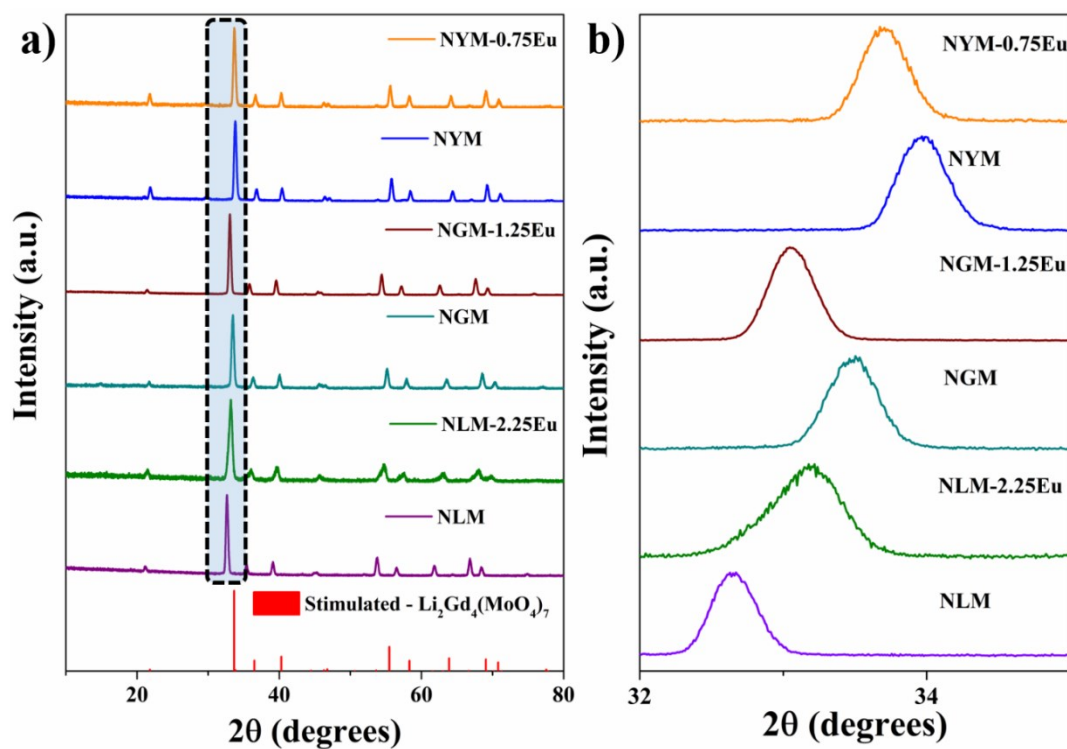


Fig. S1 a) PXRD pattern of the selected phosphor compositions, b) enlarged XRD pattern from 32-35°.

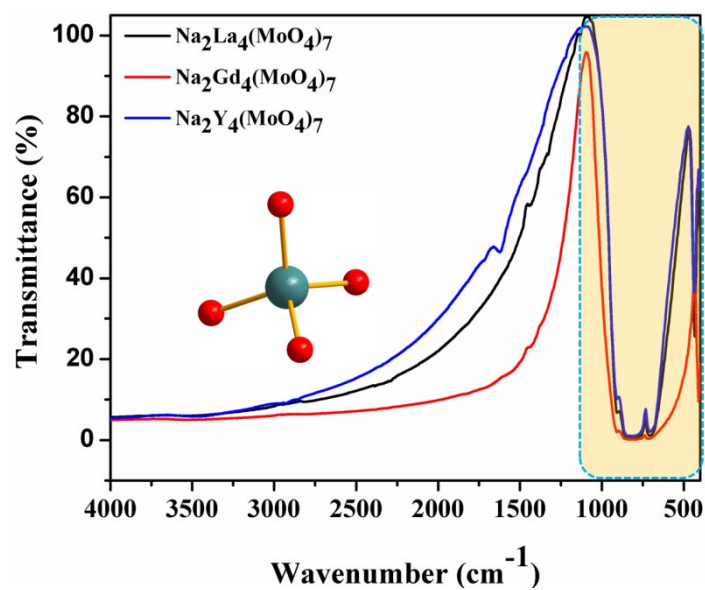


Fig. S2 FT-IR spectrum of $\text{Na}_2\text{Ln}_4(\text{MoO}_4)_7$ [Ln = La, Gd and Y] phosphor.

Table ST2:Judd – Ofelt Parameters of NGM:Eu³⁺ phosphor.

| Concentration of Eu ³⁺ | Judd – Ofelt Parameters | | | | |
|--------------------------------------|--------------------------------------|--------------------------------------|------------------------------|------------------------------|------------------------------|
| | Ω_2 | Ω_4 | A_{0-1} in S ⁻¹ | A_{0-2} in S ⁻¹ | A_{0-4} in S ⁻¹ |
| | (10 ⁻¹⁹ cm ²) | (10 ⁻²⁰ cm ²) | | | |
| 0.25 | 1.1701 | 3.9248 | 50 | 959.4635 | 156.2807 |
| 0.5 | 1.2072 | 3.4890 | 50 | 989.8101 | 138.9291 |
| 0.75 | 1.2228 | 4.3589 | 50 | 1002.661 | 173.5618 |
| 1 | 1.2499 | 4.5698 | 50 | 1024.8141 | 181.9631 |
| 1.25 | 1.2807 | 4.9196 | 50 | 1050.1093 | 195.8900 |
| 1.5 | 1.2469 | 2.6851 | 50 | 1022.3967 | 106.9170 |
| 1.75 | 1.2278 | 4.5046 | 50 | 1006.7118 | 179.3664 |
| 2 | 1.2134 | 4.8061 | 50 | 994.9432 | 191.3713 |

Table ST3:Judd – Ofelt Parameters of NYM:Eu³⁺ phosphor.

| Concentration of Eu ³⁺ | Judd – Ofelt Parameters | | | | |
|--------------------------------------|--------------------------------------|--------------------------------------|------------------------------|------------------------------|------------------------------|
| | Ω_2 | Ω_4 | A_{0-1} in S ⁻¹ | A_{0-2} in S ⁻¹ | A_{0-4} in S ⁻¹ |
| | (10 ⁻¹⁹ cm ²) | (10 ⁻²⁰ cm ²) | | | |
| 0.25 | 1.2039 | 4.6579 | 50 | 987.0965 | 185.4697 |
| 0.5 | 1.2246 | 4.3001 | 50 | 1004.0930 | 171.2253 |
| 0.75 | 1.343 | 5.0691 | 50 | 1101.1524 | 201.8425 |
| 1 | 1.2951 | 5.4590 | 50 | 1061.8900 | 217.3692 |
| 1.25 | 1.2531 | 5.3527 | 50 | 1027.4406 | 213.1382 |
| 1.5 | 1.2308 | 4.7206 | 50 | 1009.1523 | 187.9660 |
| 1.75 | 1.2205 | 5.1091 | 50 | 1000.7743 | 203.4388 |
| 2 | 1.1997 | 4.6820 | 50 | 983.6950 | 186.4295 |

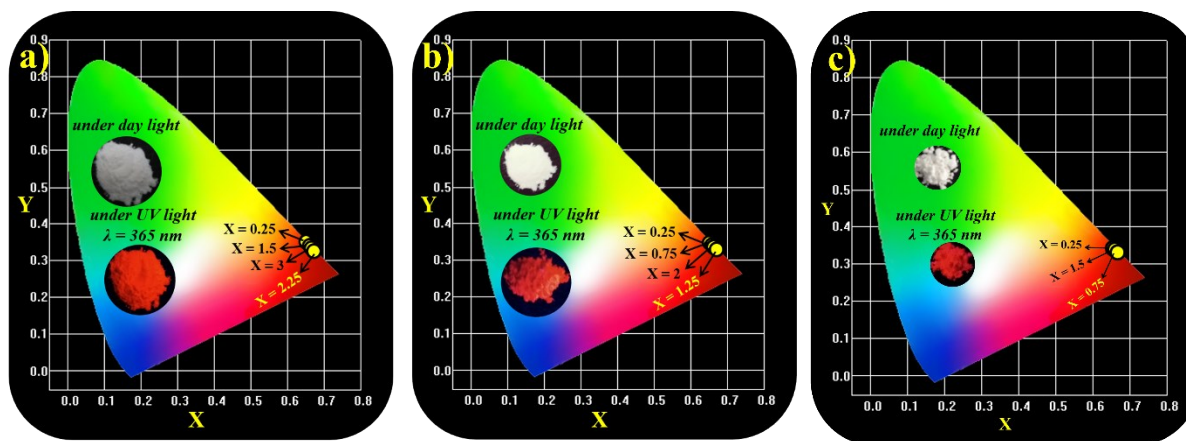


Fig. S3 CIE of Eu³⁺ activated Na₂Ln₄(MoO₄)₇ [Ln = a) La, b) Gd and c) Y] red phosphors.

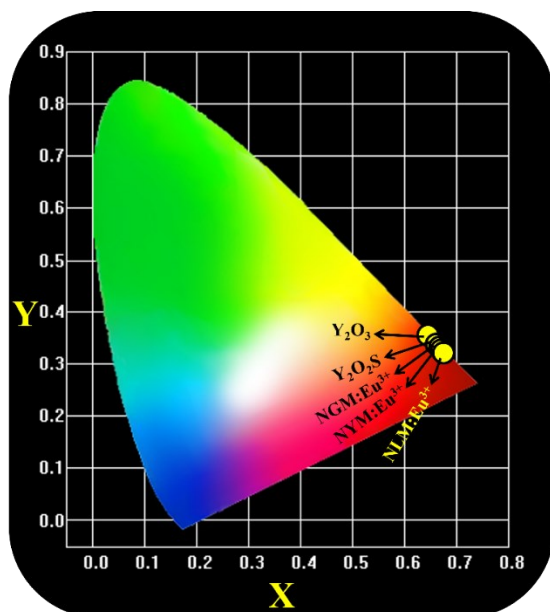


Fig. S4 Comparative CIE of Eu^{3+} activated $Na_2Ln_4(MoO_4)_7$ red phosphor with commercial phosphor.

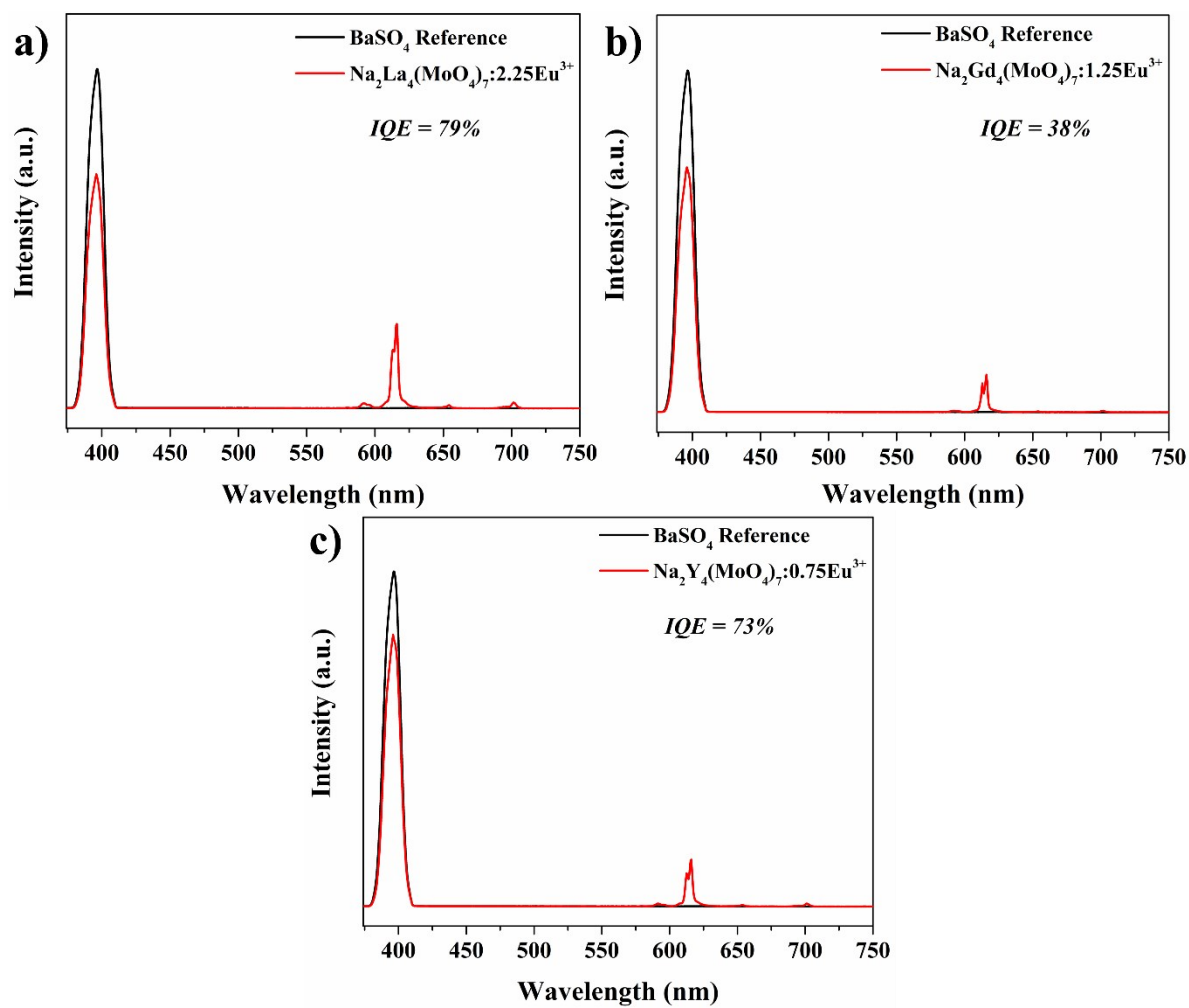


Fig. S5 Internal quantum efficiency of Eu^{3+} activated $\text{Na}_2\text{Ln}_4(\text{MoO}_4)_7$ [Ln = a) La, b) Gd and c) Y] red phosphors.

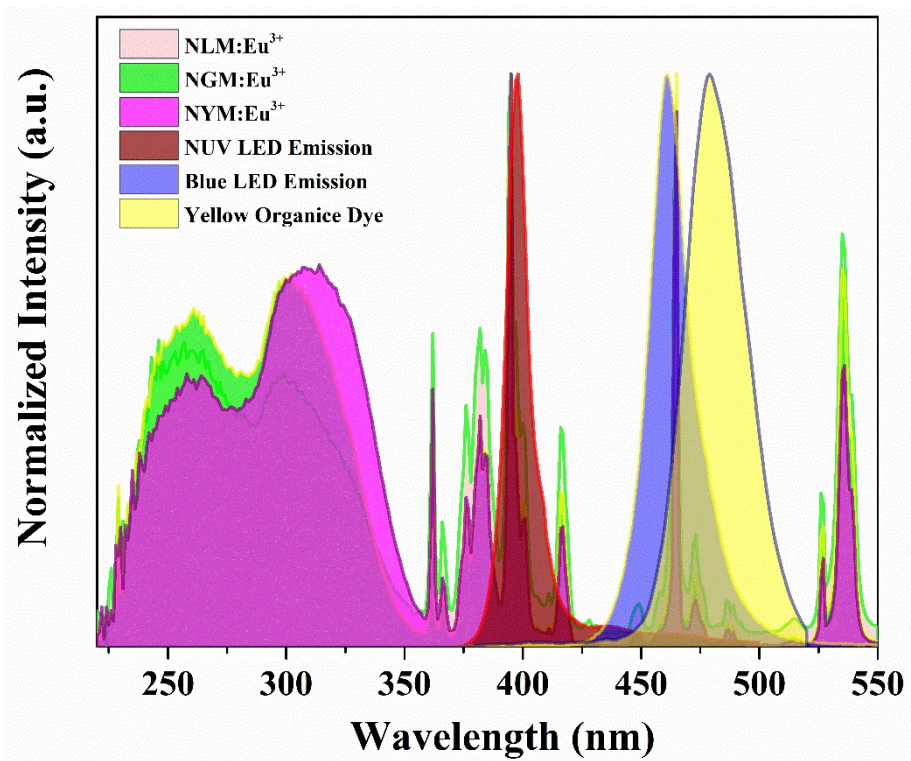


Fig. S6 Excitation of Eu^{3+} activated $\text{Na}_2\text{Ln}_4(\text{MoO}_4)_7$ [$\text{Ln} = \text{La}, \text{Gd}$ and Y] red phosphors, yellow organic dye and emission of nUV-LED and blue LED.