

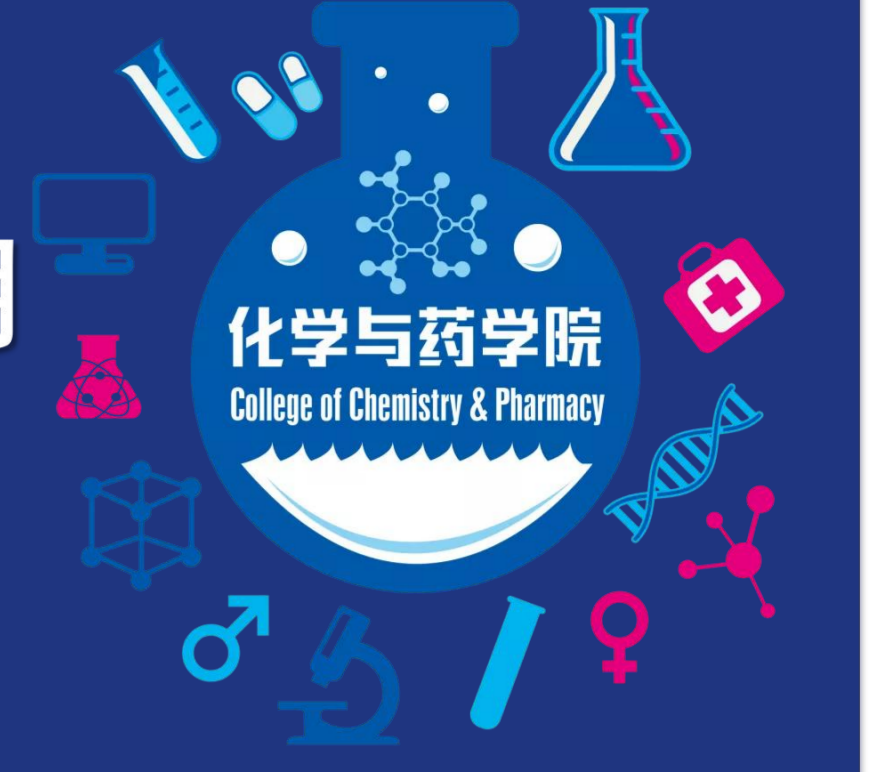
Synthesis and photoluminescence properties of a novel double perovskite $\text{NaGdMgTeO}_6:\text{Sm}^{3+}$ red-emitting phosphor for plant growth LEDs and w-LEDs



一种新型双钙钛矿型 $\text{NaGdMgTeO}_6:\text{Sm}^{3+}$ 红色荧光粉的合成和光学性质表征及其在植物照明LED和白光LED中的应用

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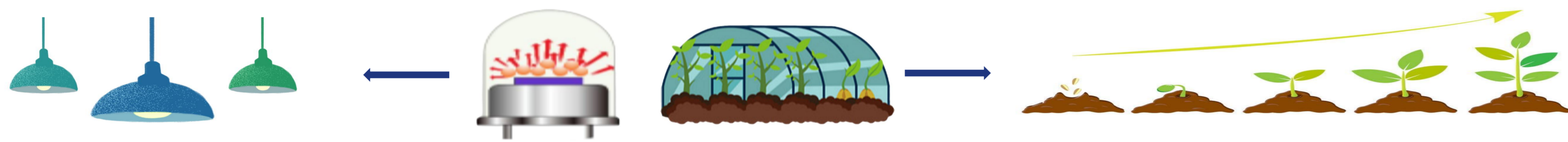
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Introduction

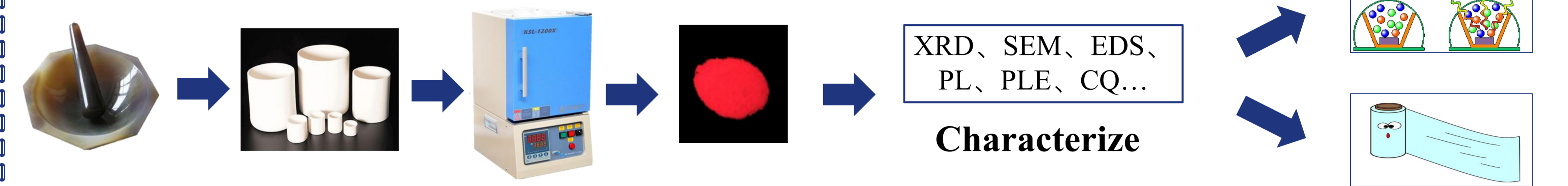
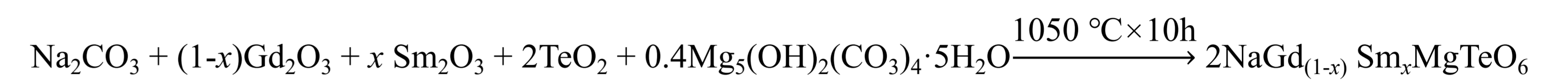
Due to the rapid development of industrialization, extreme weathers happened constantly, the lack of useful light greatly endangers crop yield. Besides, people are increasingly looking for the high quality of plants. Based on these problem, LEDs and optical convertible films are being proposed as a means of promoting plant growth due to their environmentally friendly nature and low energy consumption.

In this work, $\text{NaGdMgTeO}_6:\text{Sm}^{3+}$ were successfully synthesis. Its structure and optical properties were investigated. Finally, Sm^{3+} -doped NaGdMgTeO_6 phosphors were used for the fabrication of red LED, w-LED and optical converting films for the first time.



Experimental Details

A series of $\text{NaGdMgTeO}_6:x \text{ mol}\% \text{Sm}^{3+}$ samples ($x = 0.5, 1, 2, 5, 10, 15, 20, 30$) were synthesized via a solid-state reaction. The obtained powder was collected for further measurement.



Results and Discussion

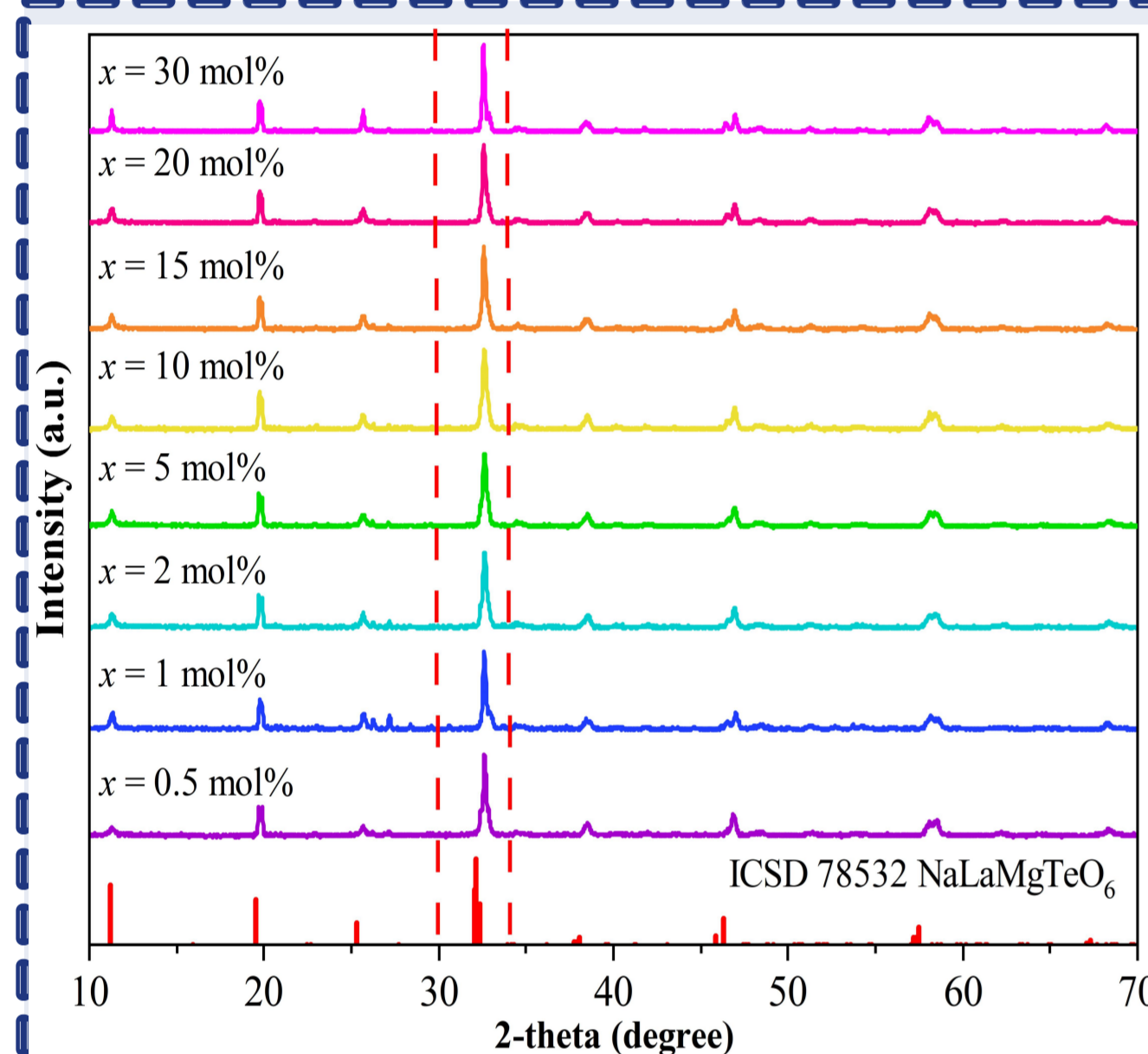


Fig. 1 The XRD patterns of $\text{NaGdMgTeO}_6:x \text{ mol}\% \text{Sm}^{3+}$.

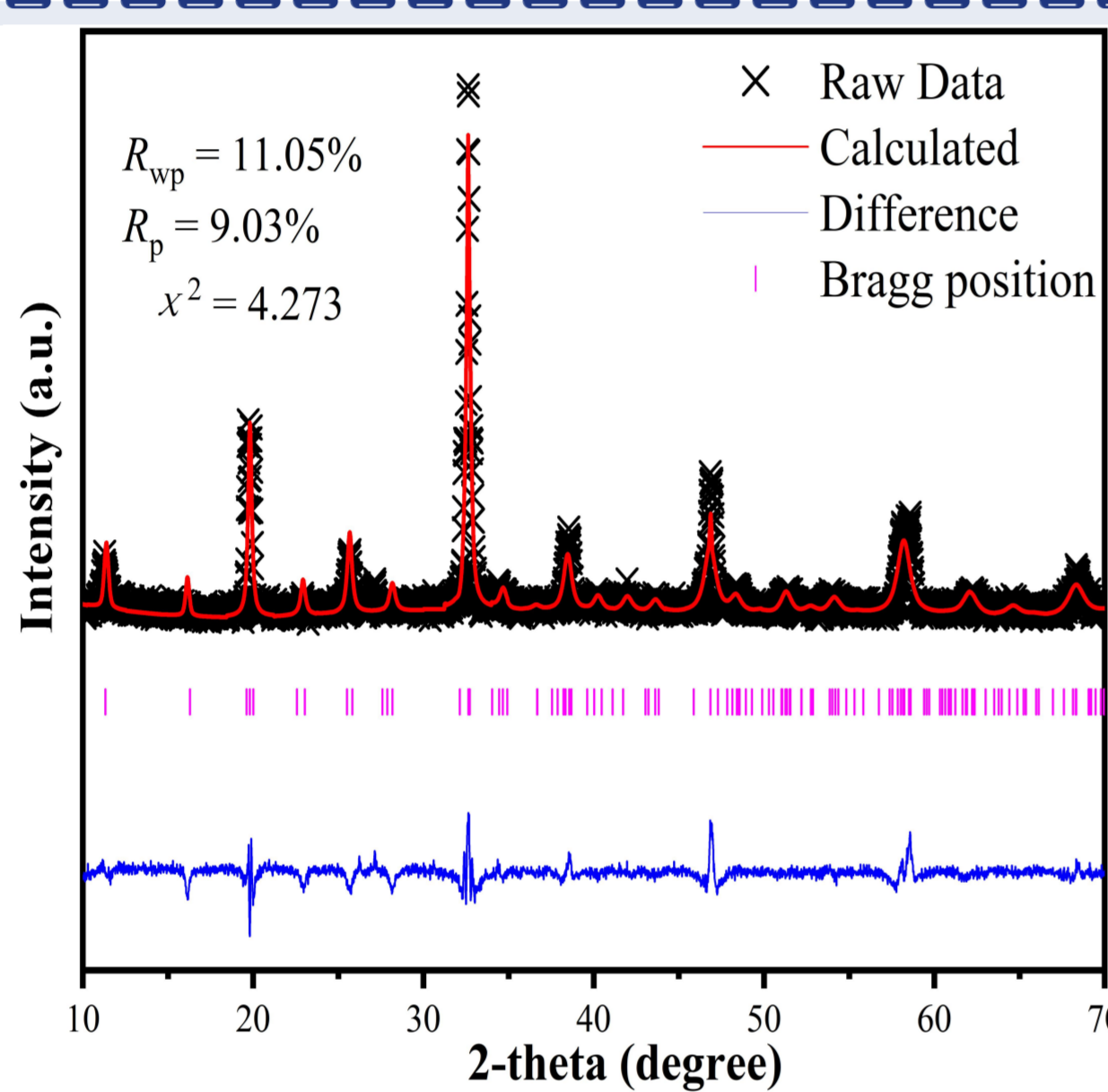


Fig. 2 The rietveld refinement of the representative NaGdMgTeO_6 phosphor.

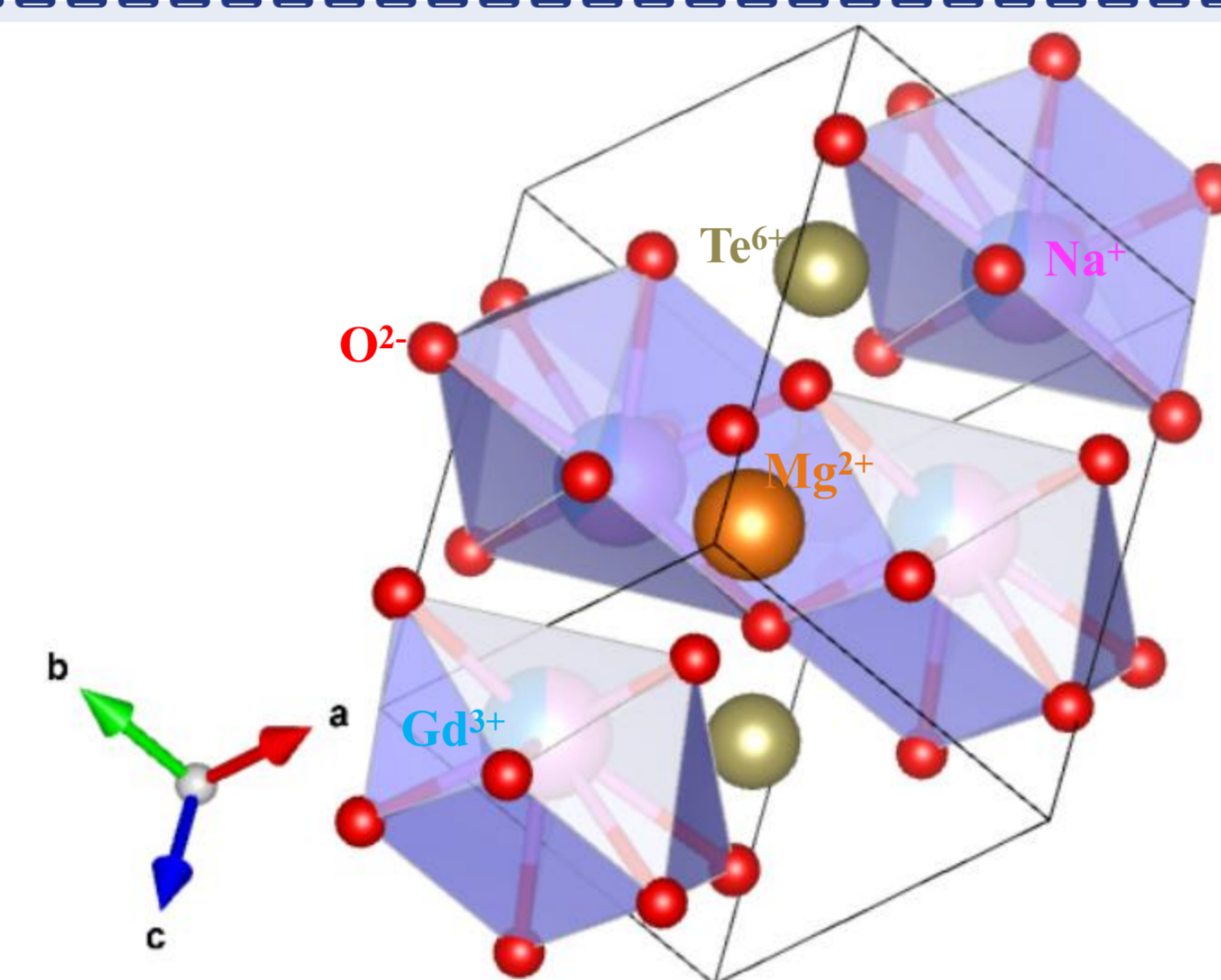


Fig. 3 Crystal structure of NaGdMgTeO_6 and the octahedra of NaO_6 or GdO_6 .

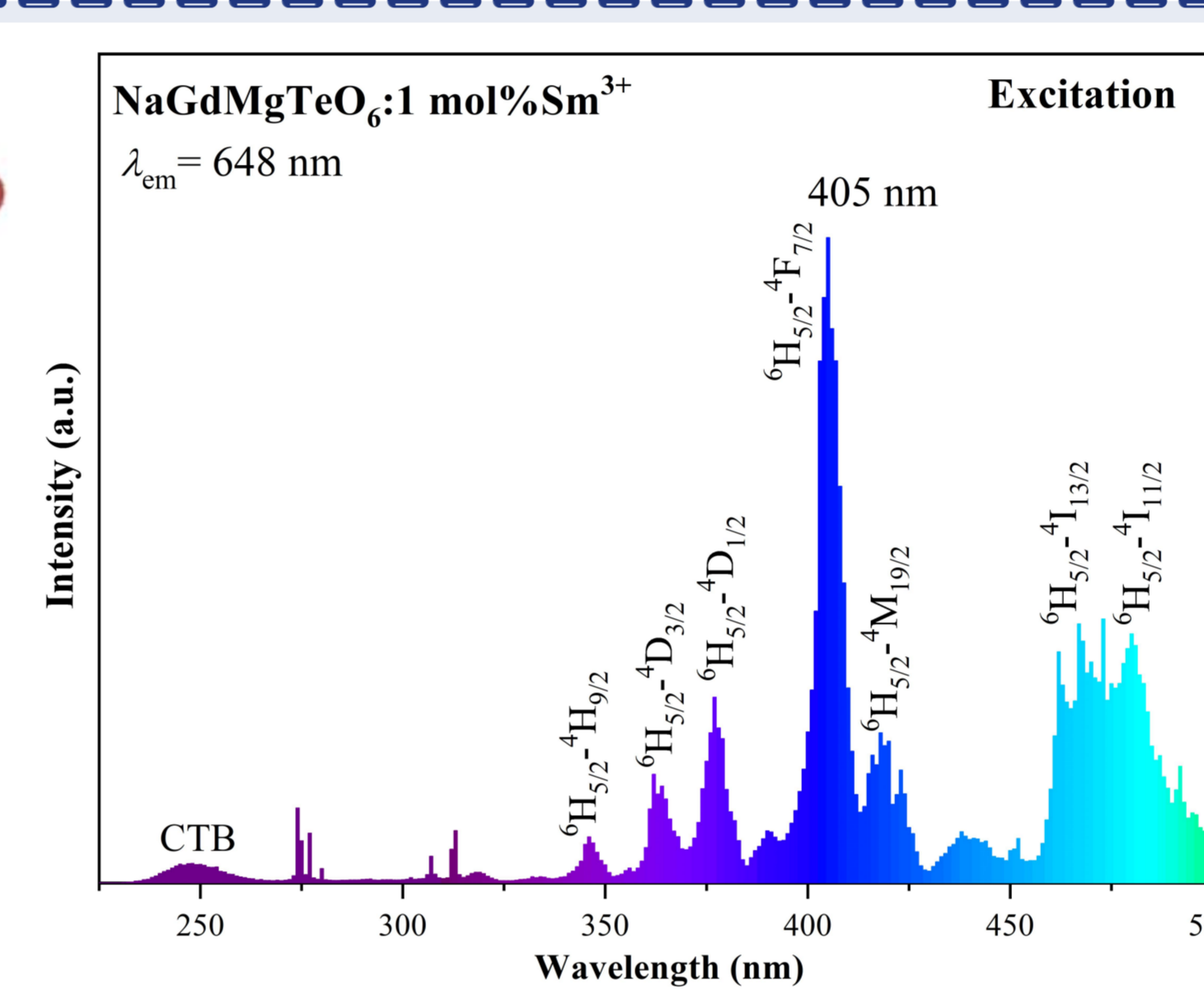


Fig. 4 Emission spectrum of $\text{NaGdMgTeO}_6:1 \text{ mol}\% \text{Sm}^{3+}$ ($\lambda_{\text{em}} = 648 \text{ nm}$).

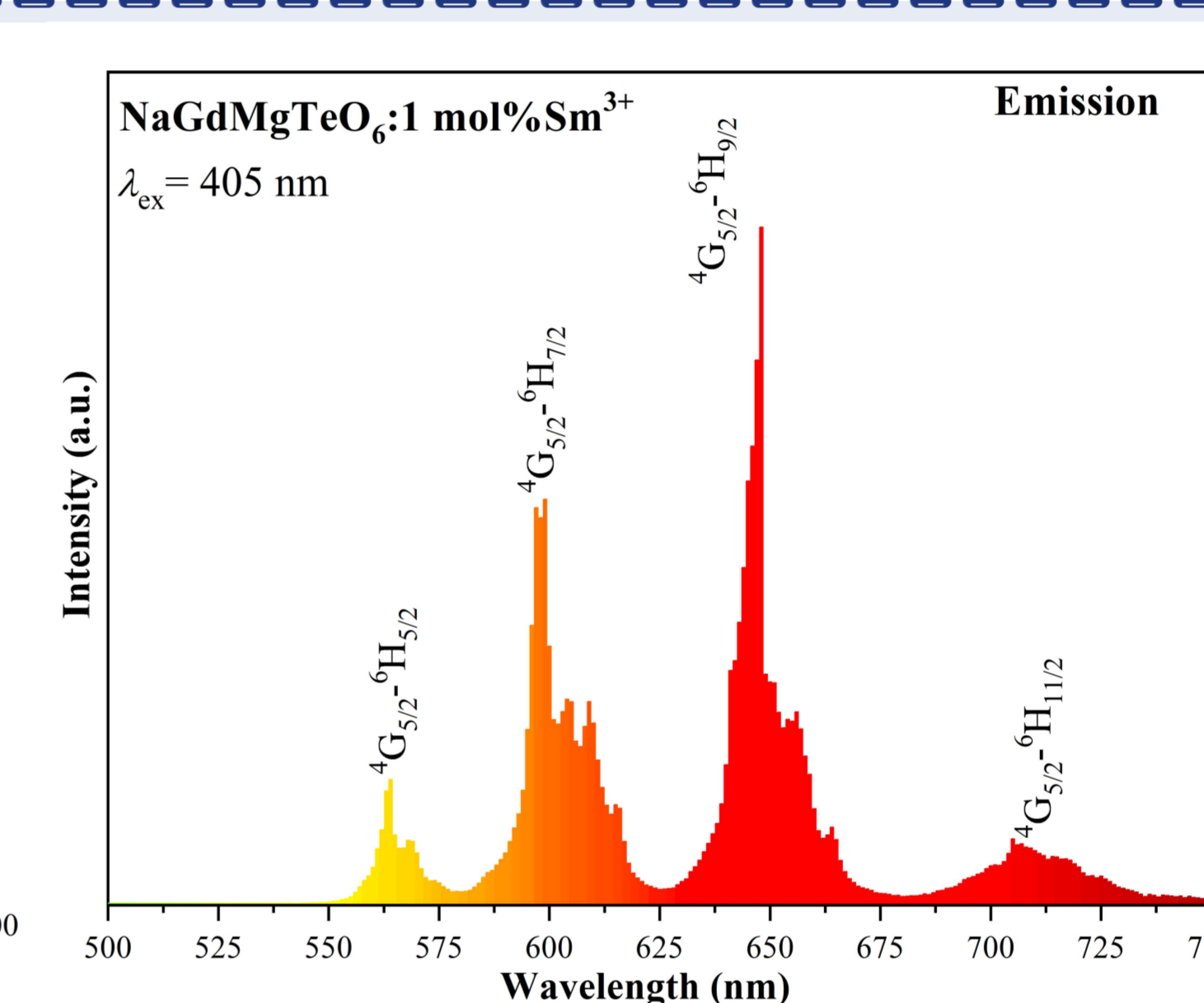


Fig. 5 Emission spectrum of $\text{NaGdMgTeO}_6:1 \text{ mol}\% \text{Sm}^{3+}$ ($\lambda_{\text{ex}} = 405 \text{ nm}$).

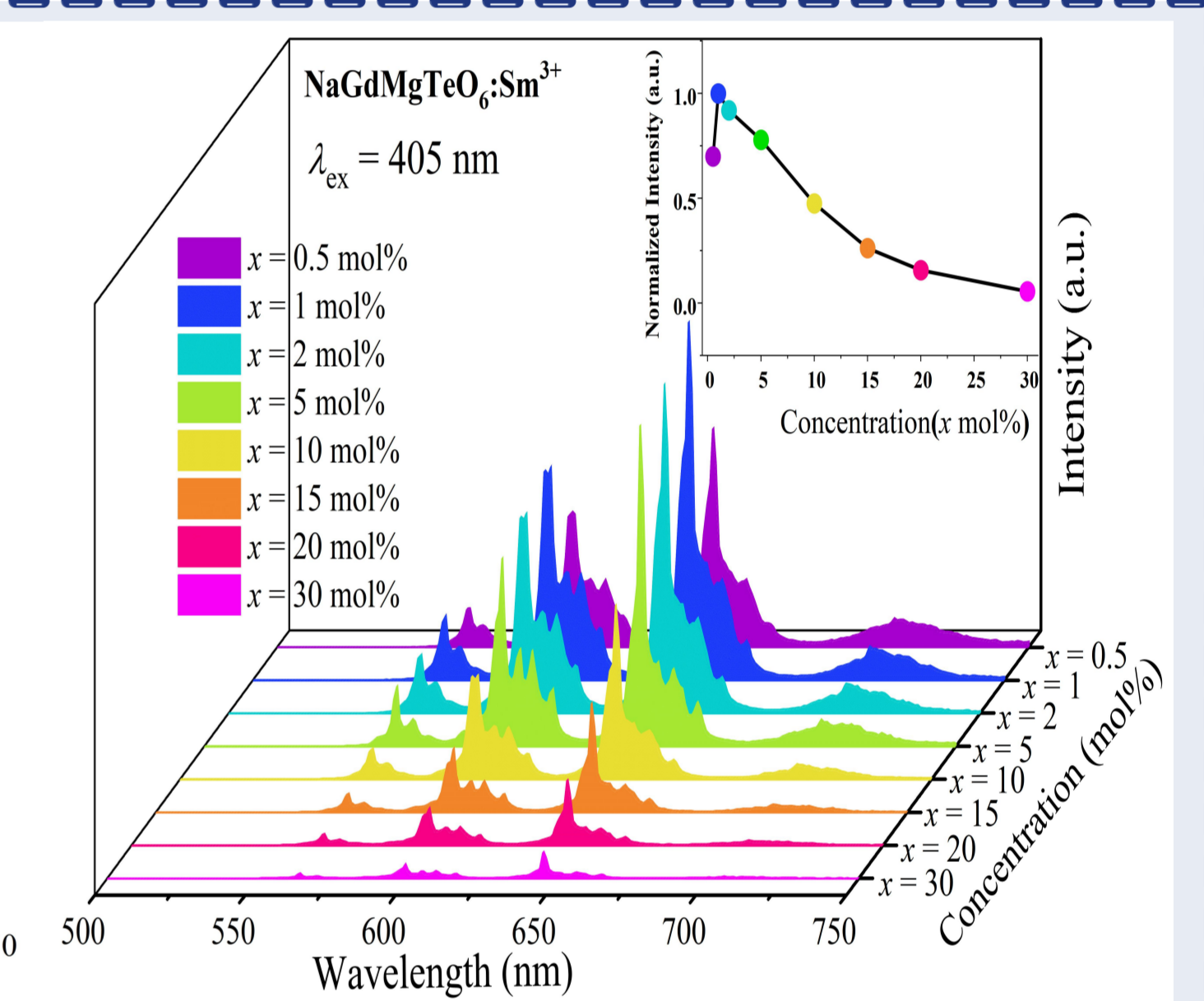


Fig. 6 The PL spectra of $\text{NaGdMgTeO}_6:x \text{ mol}\% \text{Sm}^{3+}$ ($x = 0.5-30$) phosphors.

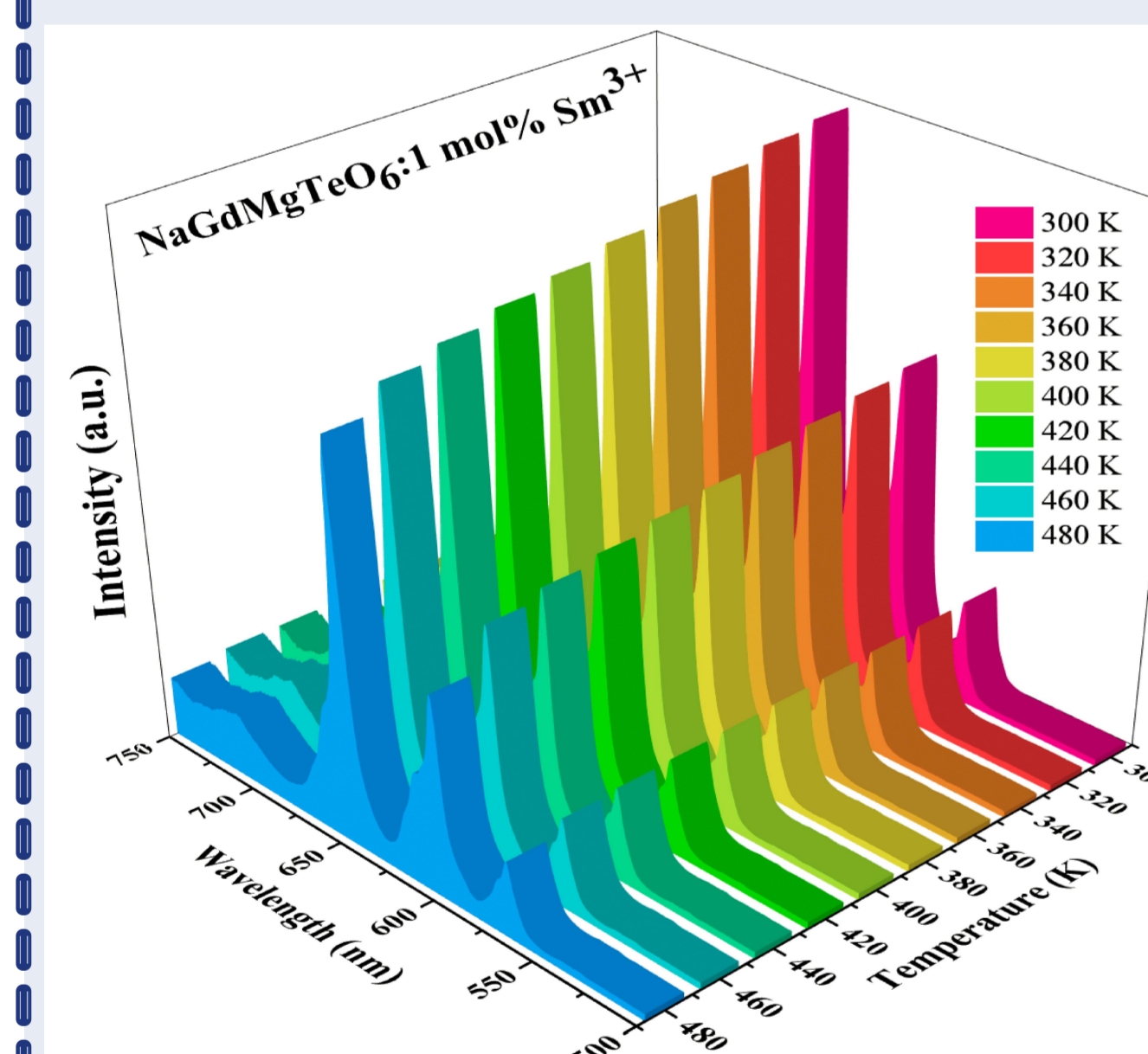


Fig. 7 Temperature-dependent PL spectra of $\text{NaGdMgTeO}_6:1 \text{ mol}\% \text{Sm}^{3+}$ phosphor.

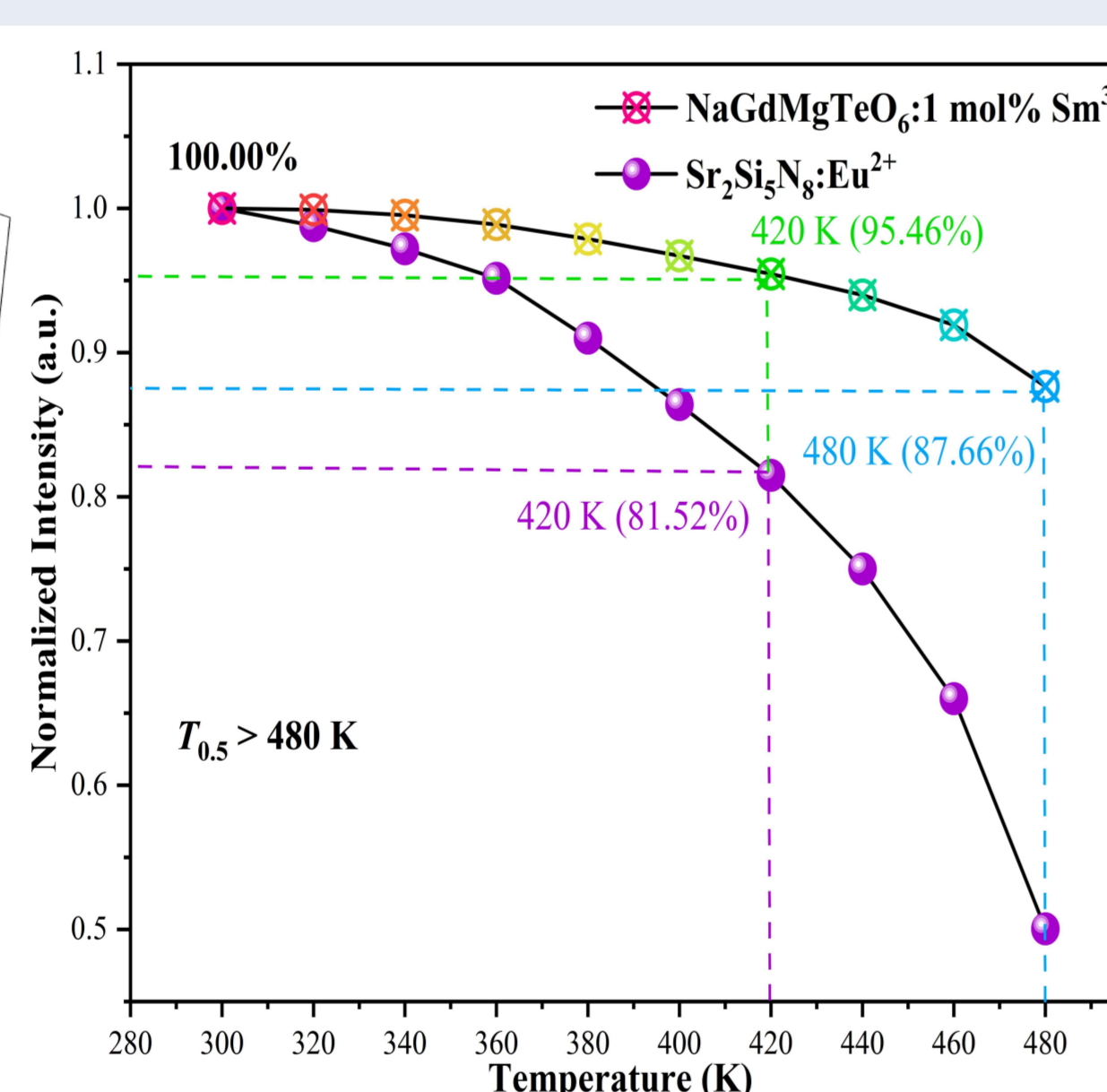


Fig. 8 Relationship between temperature and relative intensity.

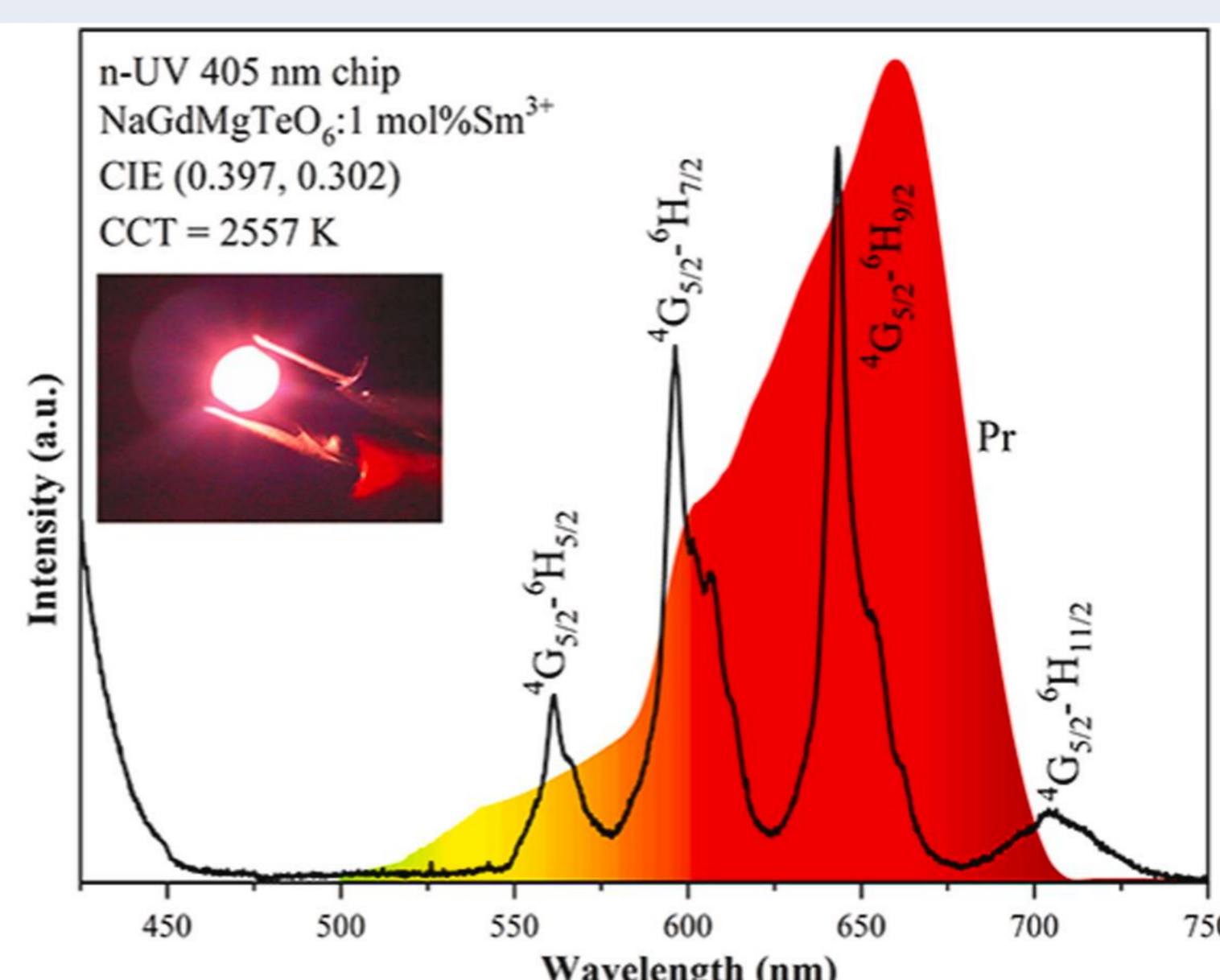


Fig. 9 The electroluminescent spectrum of the fabricated red LED overlaps with the absorption of the phytochrome Pr.

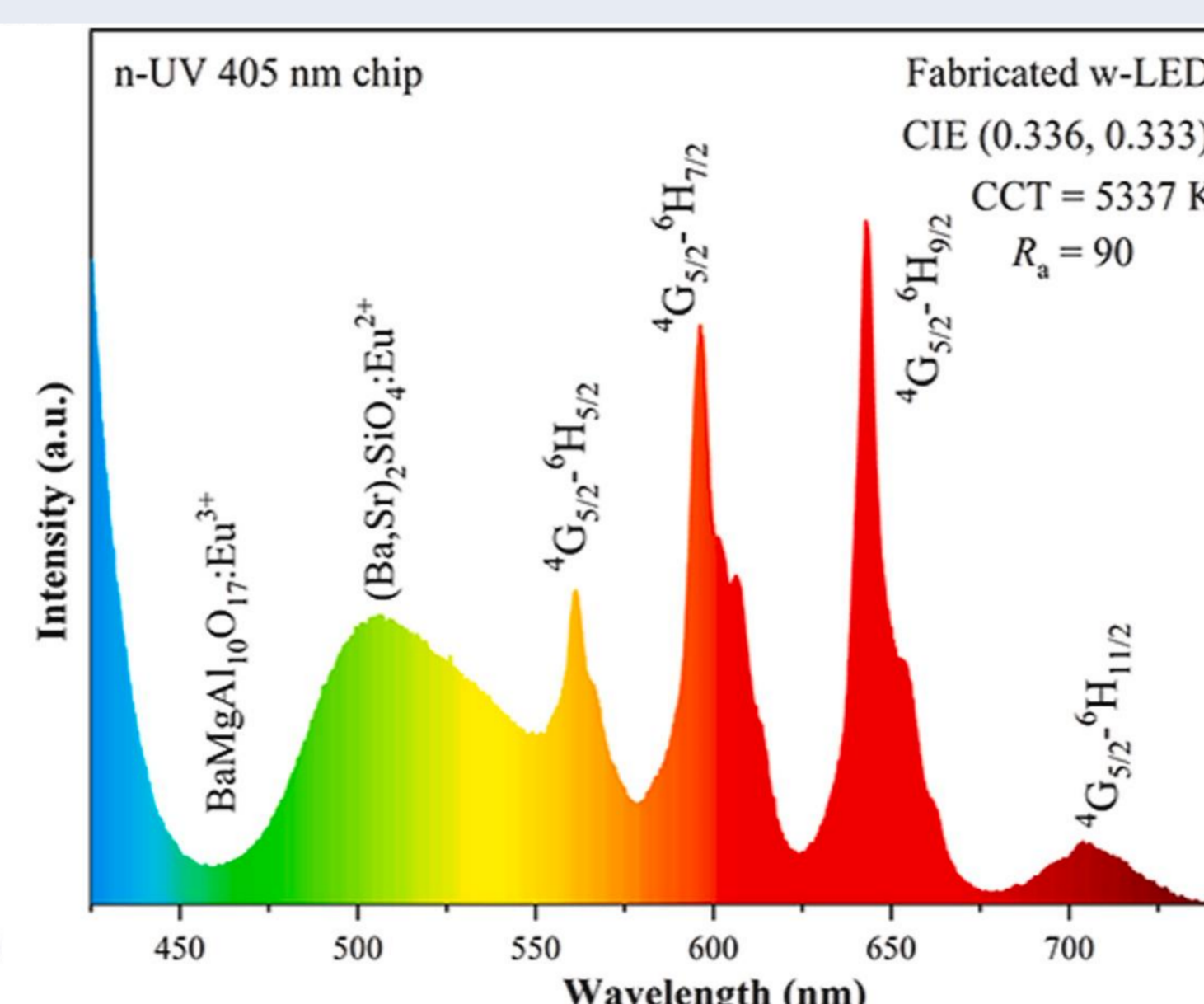


Fig. 10 Electroluminescence spectrum of the prepared w-LED.

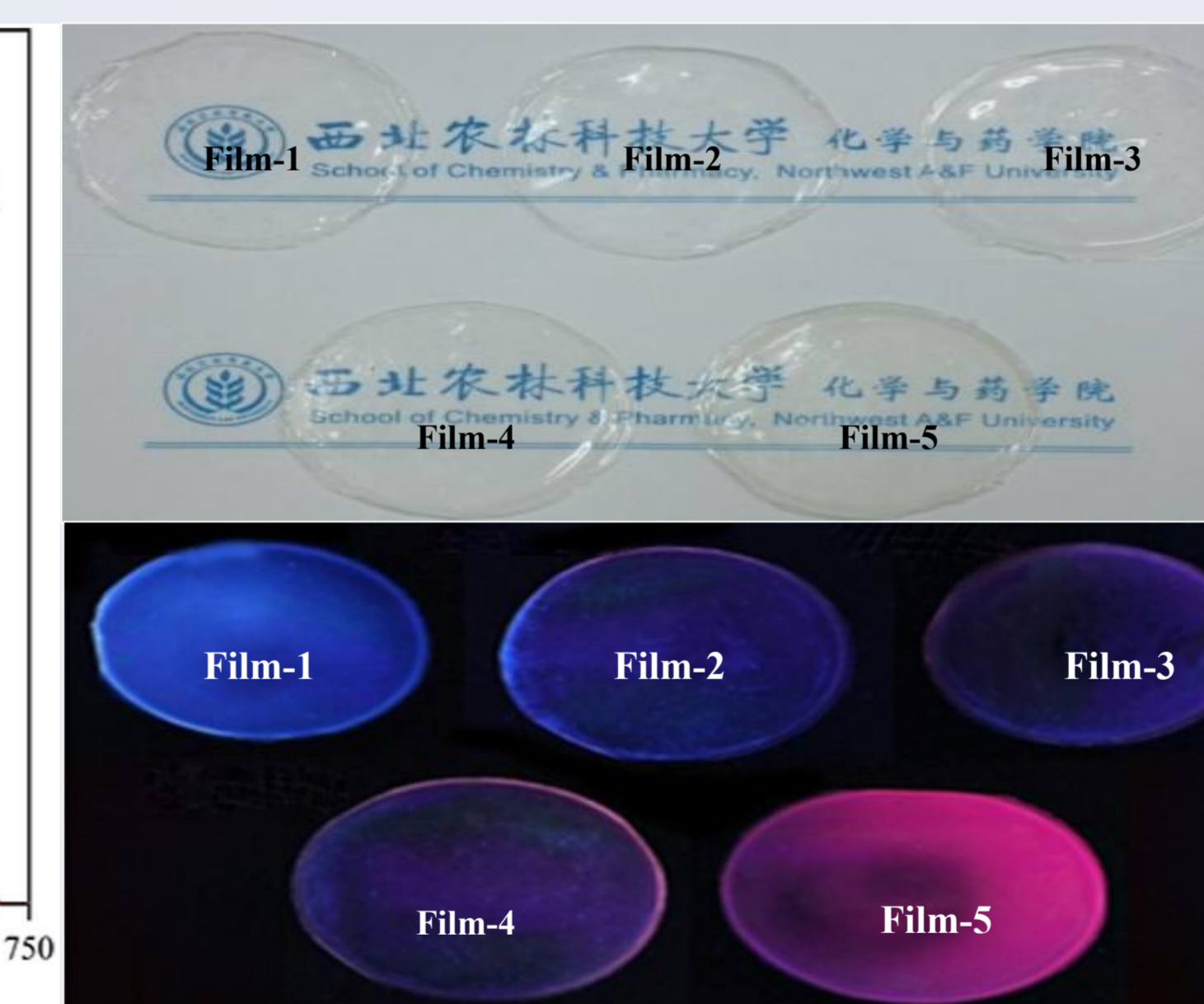


Fig. 11 The obtained agricultural film under sun light and UV-light..

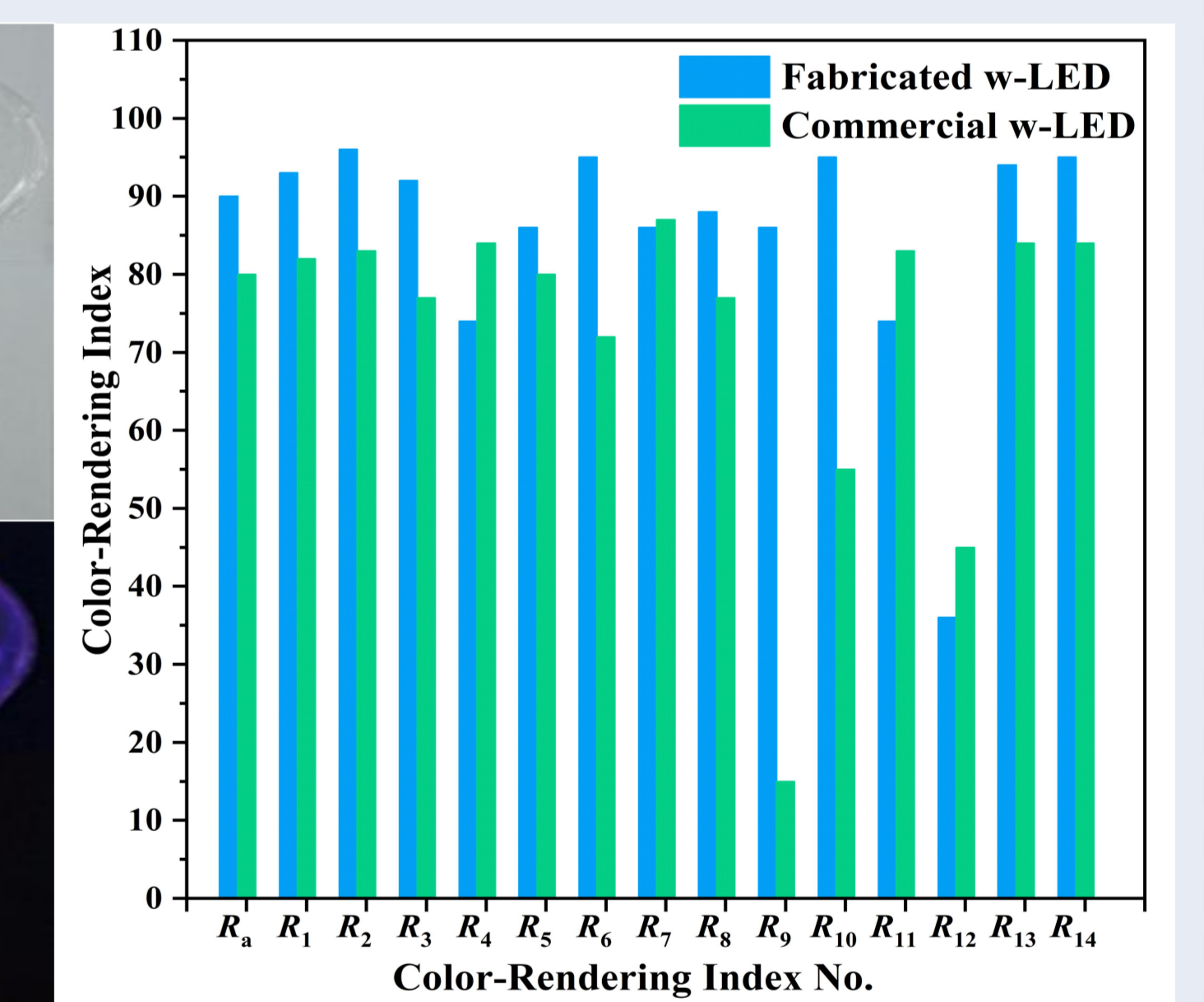


Fig. 12 The Color rendering index comparison between fabricated and commercial w-LEDs.

Conclusions

- ✓ The $\text{NaGdMgTeO}_6:\text{Sm}^{3+}$ red phosphors have been successfully prepared with a solid-state reaction technique. Besides, They showed strong red emission at 648nm under the 405 nm excitation.
- ✓ The quenching temperature is more than 480K, and the E_a is as high as 0.293 eV, demonstrating the excellent thermal stability of $\text{NaGdMgTeO}_6:\text{Sm}^{3+}$.
- ✓ The plant growth LED exhibited excellent spectral matching. A w-LED with suitable CCT (5337 K), high R_a (90), and CIE (0.336, 0.333) was prepared.
- ✓ The results of these studies suggest that $\text{NaGdMgTeO}_6:\text{Sm}^{3+}$ is a suitable replacement for commercial red phosphors used for horticultural and w-LED applications.

Acknowledgements

- ✓ The work is supported by the Undergraduate Innovation Fund of Northwest A&F University, China (X202310712514).
- ✓ For more details, please contact with yuruijin@nwsuaf.edu.cn or 2856279639@qq.com.

Achievements

- ✓ 相关成果在2023年第九届中国国际“互联网+”大学生创新创业大赛陕西赛区省级复赛中获得金奖
- ✓ 团队成员累计参与发表了两篇SCI论文

