Highly efficient and stable near-infrared phosphor for night vision and bio-imaging

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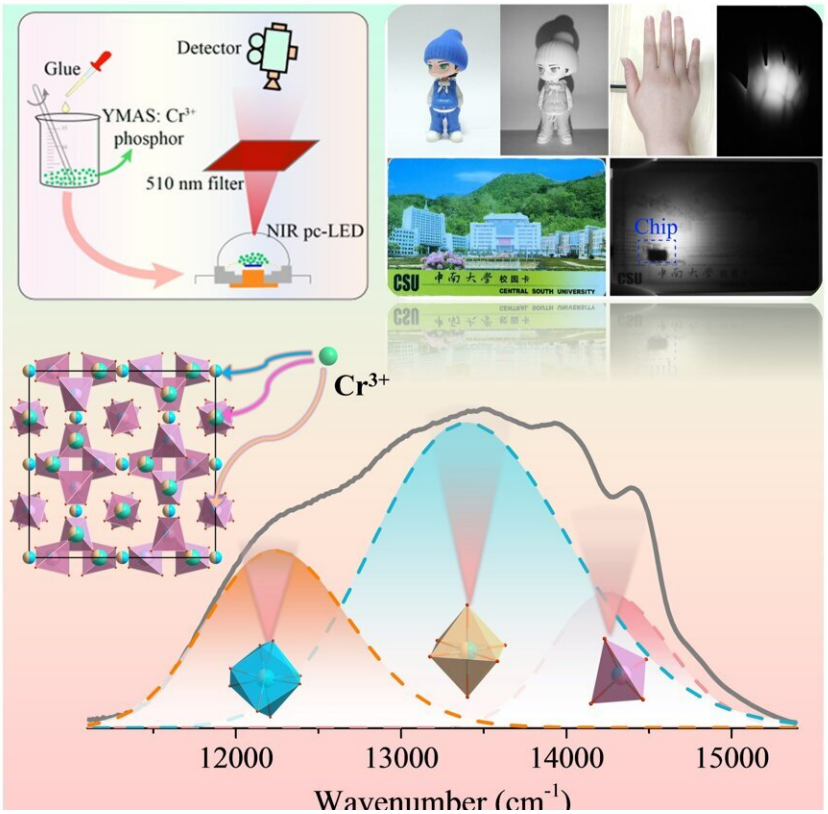

Broadband near-infrared luminescence theory and application. Credit: Gui-Hua Li, et al

Near-infrared (NIR) light source, characterized by non-destructive and rapid detection, has a wide range of applications in diverse fields

including food testing, safety, sensing, agricultural production and biomedicine. The availability of a compact, highly efficient and low-cost NIR phosphor is a key factor in achieving its wide application.

NIR pc-LED, boasting qualities such as lower cost and adjustable emission wavelength, has received widespread attention. The key lies in the development of NIR luminescent materials with broadband emission, high luminous efficiency and thermal stability. The tunable luminescent properties of Cr^{3+} have attracted the attention of researchers.

Nevertheless, the diversity in Cr^{3+} luminescence centers across various hosts poses a challenge. In previous studies, there are different views on whether the near-infrared luminescence of Cr^{3+} comes from 4-ligand or 6-ligand or 8-ligand. Systematic and in-depth research is essential to elucidate the relationship between Cr^{3+}'s occupancy habit and responding photoluminescence properties.

To that end, a team of researchers led by Gemei Cai at the Central South University in China, examined the luminescent properties and crystal field environment of Cr^{3+} in special matrix $Y_2Mg_2Al_2Si_2O_{12}$ with multiple cationic sites. The NIR pc-LEDs were made from the developed NIR-emitting phosphors, and the potential applications of these NIR light sources in night vision, bio-imaging, and non-intrusive detection were demonstrated.

"With the help of crystallographic investigation, spectroscopy characterization, and crystal-field-strength analyses, Cr1, Cr2, and Cr3 are verified to be originated from Cr^{3+} in Al/SiO_4 tetrahedral, Mg/AlO_6 octahedral, and Y/MgO_8 dodecahedral sites, respectively," says Cai.

"Potential applications for this assembled miniaturized NIR pc-LED include night visualization, bio-imaging, and non-intrusive detection, as demonstrated by the clear visualization of blood vessels in a hand as well

as chip and circuit layout on a magnetic card under NIR illumination."

The findings, published in the journal *Advanced Powder Materials*, present Cr^{3+}-activated NIR phosphors with features of outstanding luminescence for multi-functional applications. The study also demonstrates the feasibility of the strategy via designing the multi-luminescent centers with intermediate-weak crystal field environment for Cr^{3+} to achieve broadband emission.

More information: Gui-Hua Li et al, Achieving broadband near-infrared luminescence in Cr3+-Activated Y2Mg2Al2Si2O12 phosphors via multi-site occupancy, *Advanced Powder Materials* (2024). DOI: 10.1016/j.apmate.2024.100186

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