# Luminescence characteristics of Eu-doped $CaF_2$ crystals vary with radiation type, study shows

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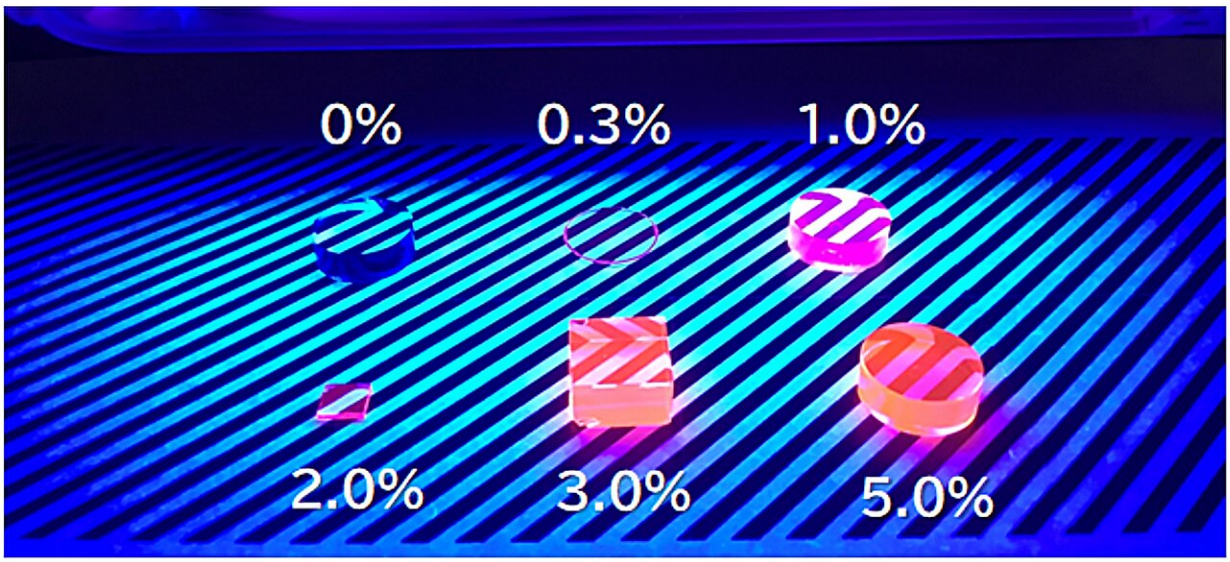


Photograph of $CaF_2$:Eu crystal samples grown, processed, and used in this study. Under UV illumination (black light), the characteristic luminescence of Eu is visible. At low Eu concentrations, the crystals emit violet light from $Eu^{2+}$, while higher Eu concentrations result in dominant red emission from $Eu^{3+}$. Credit: *Scientific Reports* (2025). DOI: 10.1038/s41598-025-17570-5

Scintillators convert radiation energy into light and are utilized in a variety of fields including medicine and security. Of the many scintillators, Eu (europium)-doped $CaF_2$ (calcium fluoride) crystals stand out due to their high light yield (approximately 20,000 photons/MeV), excellent optical transparency, and chemical stability.

Previously, the emission wavelength of scintillators was thought to be independent of the type of radiation. In a new study from the University of Tsukuba, multiple $CaF_2$ crystals with different Eu doping concentrations were synthesized and irradiated with alpha particles and X-rays to investigate systematically the color (wavelength) and intensity of the emitted light.

The results, published in *Scientific Reports*, showed that the ratio of $Eu^{2+}$-induced emission (wavelength: ~420 nm) to $Eu^{3+}$-induced emission (wavelength: 590–695 nm) varies depending on the type of radiation. Moreover, for the same sample, when $Eu^{2+}$ emission was held constant, $Eu^{3+}$ emission was found to be approximately twice as strong under α particle irradiation as compared to X-ray irradiation.

This suggests that differences in light color could be used to identify radiation types, a finding that has the potential for use in unique applications, including dose measurements in complex environments such as nuclear facility decommissioning sites.

These findings are expected to pave the way for new particle identification methods and next-generation radiation detection technologies. Moving forward, the researchers plan to develop a technique that records the tracks of passing radiation in color by integrating this method with an optical system using lenses, thereby creating a means to identify particle types, such as alpha particles and X-rays, based on color.

**More information:** Takashi Iida et al, Emission characteristics of $Eu^{2+}$ and $Eu^{3+}$ under x-ray and alpha irradiation in Eu-doped $CaF_2$ crystals, *Scientific Reports* (2025). DOI: 10.1038/s41598-025-17570-5

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