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Probing structural defects and X-ray induced persistent luminescence mechanisms on rare earth-doped strontium sulfide materials†

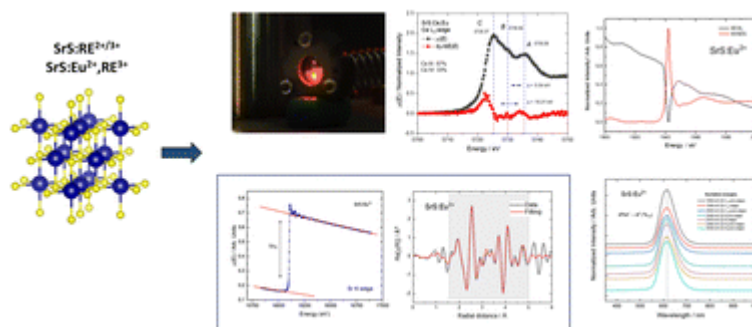


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Abstract

Persistent luminescence is related to the existence of point defects in the crystal structure, which can be induced by the insertion of dopant ions to create trap levels for charge carriers. Strontium sulfide (SrS) is a promising host for X-ray activated phosphors due to its high luminescence yield and X-ray absorption efficiency. While the mechanisms of UV- and visible light-induced luminescence in rare-earth doped SrS have been previously explored, this work focuses on understanding X-ray induced mechanisms using synchrotron radiation techniques. Extended X-ray absorption fine structure (EXAFS) analysis suggested that rare-earth ions incorporate into the SrS lattice primarily as substitutional defects, with structural distortions depending on the differences in ionic radii between Sr^{2+} and $\text{RE}^{2+/3+}$. X-ray absorption near edge structure (XANES) spectra revealed the mixed-valence nature of Ce in SrS:Ce and SrS:Eu,Ce materials, and also that X-ray irradiation triggers complex charge transfer processes. The X-ray excited optical luminescence (XEOL) results showed that co-doped samples exhibited longer persistent luminescence decay times than their single-doped counterparts due to the increased number of defects. These findings provide new insights into the interplay between crystal defects and persistent luminescence in X-ray activated phosphors, contributing to the design of more efficient materials for applications such as medical imaging, optical information storage, and industrial sensing.



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