Uniwersytet Wrocławski

Repozytorium

Plik pochodzi z repozytorium Wydziału Chemii Uniwersytetu Wrocławskiego

Fine structure in high resolution $4f^7$-$4f^6$5d excitation and emission spectra of X-ray induced Eu^{2+} centers in $LuPO_4$:Eu sintered ceramics.

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Rok wydania

2019

Czasopismo

Journal of Luminescence

Numer woluminu

207

Strony

435-442

DOI

10.1016/j.jlumin.2018.11.050

Kolekcja

Naukowa

Język

Angielski

Typ publikacji

Artykuł

Streszczenie

X-ray induced effects in $LuPO_4:Eu^{3+}$ sintered thermoluminescent material were investigated by absorption and photoluminescence measurements between 20 and 300K. Evidence for $Eu^{3+} \rightarrow Eu^{2+}$ conversion upon exposure to X-rays was obtained as narrow band blue Eu^{2+} photoluminescence was observed. The low temperature luminescence of Eu^{2+} ions in X-rayed $LuPO_4$:Eu ceramics showed a unique fine structure with a sharp zero-phonon line at 425.8nm and well-resolved vibronic structure. Excitation spectra of the Eu^{2+} luminescence revealed a rich structure in which individual $4f^7 \rightarrow 4f^6(^7F_J)5d^1$ zero-phonon lines accompanied by vibronic transitions were identified. A detailed analysis allowed an accurate calculation of the Eu^{3+}-like $4f^6(^7F_J)$ core levels in the $4f^6 5d^1$ excited configuration. The $4f^6$ core splitting is different from that of the ^7F_J states for Eu^{3+} in $LuPO_4$, providing evidence for the role of $4f^6$–5d interaction on the splitting of the $4f^6$ configuration. The unique luminescence of Eu^{2+} with a small Stokes shift and well-determined energies of $4f^6(^7F_J)5d^1$ excited states make $LuPO_4$:Eu a model system for testing theoretical models which are presently developed to calculate and predict the energy level structure and Stokes shift of $4f^n$–$4f^{n-1}5d^1$ transitions of lanthanides.

Słowa kluczowe

LuPO4, Eu2+ luminescence, Zero-phonon line, 4f6 5d excited state, High resolution spectroscopy

Adres publiczny

https://doi.org/10.1016/j.jlumin.2018.11.050

Strona internetowa wydawcy

http://www.elsevier.com

Plik został wygenerowany dnia 2026-11-15 04:31:38

Adres w repozytorium https://old.chem.uni.wroc.pl/pl/repozytorium/Foe48W7.