Área: MAT

Åkermanite doped with Europium (III) as a luminescent temperature sensor

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Highlights

Eu^{3+}-doped $Ca_2MgSi_2O_7$ was synthesized by solid-state reaction. The doped compound was studied to be applied as a temperature sensor based on the luminescent properties observed.

Abstract

The mineral Åkermanite is the magnesium endmember of the melilite group, $Ca_2MgSi_2O_7$, belonging to the tetragonal crystal system and $P\bar{4}2_1m$ space group. It presents a variety of applications due to its chemical and physical stabilities, and common precursors for its synthesis. Europium is a so-called rare earth element utilized as an activator ion in lighting devices due to its luminescent properties. In its trivalent state, the emission spectrum reveals a series of narrow bands attributed to *f-f* transitions, the most intense ones located at the orange/red spectral region from $^5D_0 \rightarrow {}^7F_J$ (J = 0, 1, 2, 3 and 4). Its emission is also applied as temperature sensors with a contactless detection method. Given the Eu^{3+} radius of 1.066 Å when the coordination number is eight[1], in the host matrix it will substitute for the eightfold coordinated Ca^{2+}, with 1.12 Å radius[1]. $(Ca_{1-x}Eu_x)_2MgSi_2O_7$ with x = 0.01, 0.025 and 0.05 were synthesized through solid-state reaction. The mixed powdered precursors $CaCO_3$, Eu_2O_3, MgO and SiO_2 went through two consecutive heat treatments at 1350°C for 8h for the formation of the phase of interest. The products with 2.5 and 5 at. % of dopant still present spurious phases. Therefore, the 1 at.% sample was utilized for the thermometry study. The emission spectra of the compound when excited at the $^7F_0 \rightarrow {}^5L_6$ transition (393.5 nm) is dominated by the hypersensitive $^5D_0 \rightarrow {}^7F_2$ transition, indicating that the site occupied has low symmetry. Under the same excitation wavelength, the host matrix also emits a broad weak band and at around 460 nm. Emission spectra of the sample were obtained from 298 to 373 K, as shown in Figure 1. The luminescence intensity ratio (LIR) of the $^5D_0 \rightarrow {}^7F_0$ transition, which is an electric dipole transition, and the $^5D_0 \rightarrow {}^7F_1$ transition, a magnetic dipole transition, as a function of the temperature presents a linear behavior (Figure 2). In conclusion, these results suggest that the material is a potential temperature sensor with only one activator.

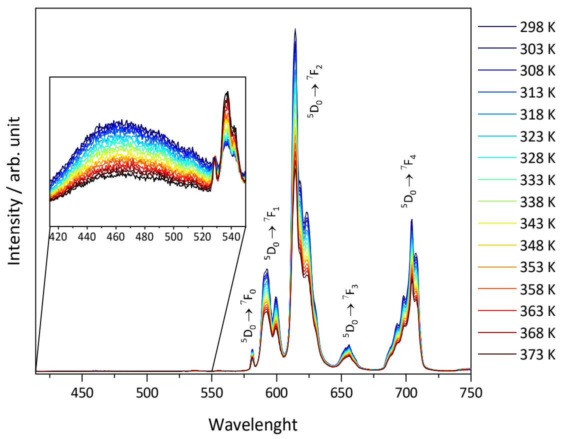

Figure 1. Emission spectra of $(Ca_{0.99}Eu_{0.01})_2MgSi_2O_7$ from 298 K to 373K.

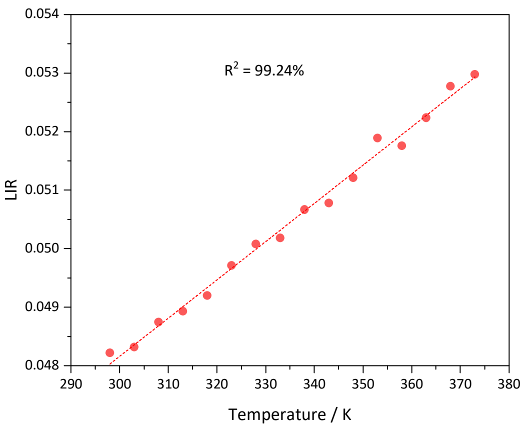

Figure 2. Luminescence Intensity Ratio between $^5D_0 \rightarrow {}^7F_0$ and $^5D_0 \rightarrow {}^7F_1$

References: [1] **Acta Crystallographica Section A**, v. 32, n. 5, p. 751-767, Sep. 1976.

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