Design of luminescent ceramic materials.

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Introduction

The development of luminescent ceramic materials has been subject of extensive research in the recent years because of their applications in devices involving the artificial production of light. Particularly, rare earths are widely used as efficient emission centers due the high transition probabilities originating from 4*f* electron configuration. In this work *Ln*TaO_4 compounds (*Ln* = rare earth) were synthesized by solid state reaction and the samples were characterized by X-Ray diffraction (XRD), Raman scattering and photoluminescence (PL) emission.

Results and Discussion

The synthesized materials exhibited three different crystal structures in function of ionic radius of the rare earth metals. La-Pr = $P2_1/c$ (#14); Nd-Tb = *I2/a* (#15) and Dy-Lu = *P2/a* (#13). For the ceramics with larger ionic radii (*Ln* = La-Pr), 36 Raman-active modes were observed. Smaller lanthanides (*Ln* = Nd-Lu) exhibited 18 Raman-active bands. All these results are in perfect agreement with group-theory calculations. Phase transitions between *I2/a* (M-type) and *P2/a* (M'-type) structures were investigated and the results showed a strong dependence with processing conditions as well as with the lanthanide size. It was also observed that M'-type fergusonite structures are stable at lower temperatures, while M-type fergusonites are stable at higher temperatures. In this case, terbium orthotantalates with M- and M'-type structures could be synthesized. The behavior of Tb^{3+} ions in self-activated orthotantalates was investigated, and photoluminescence measurements have shown that our samples present different optical properties. The emission spectra of the ceramic powders under 325 nm excitation were obtained and the emission peaks are composed by typical transitions of Tb^{3+} from $^5D_4$ level to ^7F_J (J=6,5,4,3,2). PL emission spectra (λ_{exc} = 325 nm) exhibited green emission with maximum position at around 549.2 and 543 nm for M- and M'-type structures, respectively, corresponding to the $^5D_4 \rightarrow {}^7F_5$ transitions. The color coordinates to M-$TbTaO_4$ and M'-$TbTaO_4$ were (0.410, 0.402) and (0.422, 0.385), respectively. Figure 1 shows the 1931 CIE *xy* chromaticity space for M-$TbTaO_4$ and M'-$TbTaO_4$ including the emission spectra in the inset.

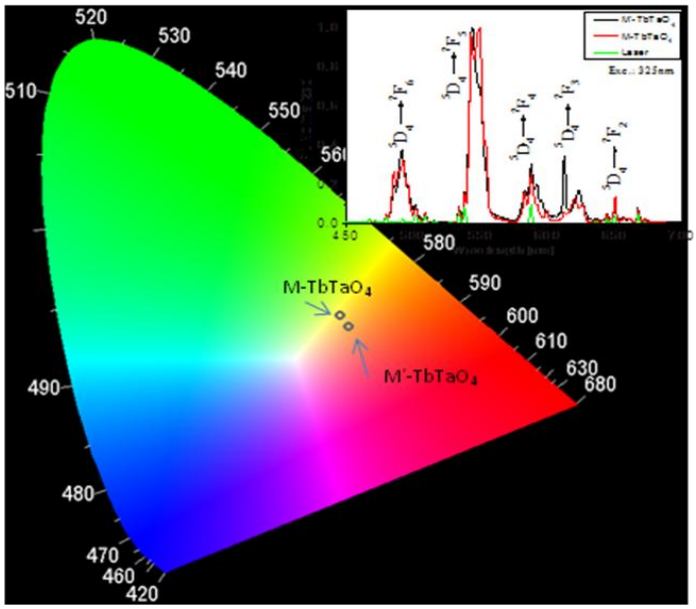

Figure 1. CIE chromaticity diagram showing the (*x,y*) color coordinates for M'-$TbTaO_4$ and M-$TbTaO_4$, besides emission spectra (inset).

Conclusions

LnTaO_4 samples were synthesized by solid state chemistry. We have performed a structural and spectroscopic characterization of M- and M'-$TbTaO_4$ systems. It was observed some variation in spectral shape, peak position, and relative intensity as a consequence of the crystal structure. The sample with Tb^{3+} presents a strong green emission related to $^5D_4 \rightarrow {}^7F_5$ transition. Chromaticity diagrams (CIE) were also determined for the samples *Ln*TaO_4, aiming to bring forward the color coordinates for this series of luminescent ceramic compounds.

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