CaTiO$_3$:Eu powders: synthesis and morphology approaches

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Abstract - CT:Eu-HTMW powders with 0.5, 1.0 and 2.0% molar ratio of Eu$^{3+}$ ions were synthesized by Microwave-Hidothermal system and heated at 140°C for 10 min and characterized by powder X-ray diffraction (XRD), FE-SEM images and room temperature photoluminescence spectroscopy. These materials present the cubes-like morphology, so the spherical particles of the Eu$^{3+}$ ions are not observed, indicating that Ca$^{2+}$ are substituted by Eu$^{3+}$ in the CaTiO$_3$ lattice and no change is observed in the typical morphology of pure CT-HTMW compounds. The decay time of the Eu$^{3+}$ $^5D_0$-$^7F_2$ transition ($\lambda_{exc}$=394, $\lambda_{em}$=614 nm) fit one exponential curve and is similar for all samples, indicating that only one type of Eu$^{3+}$ site is present in the CT framework.

Microwave assisted hydrothermal method is a potential technique for synthesize crystalline CaTiO$_3$:Eu powders being a genuine low temperature method, which allows high heating rates and short annealing times by reason of direct interaction from microwave radiation with the matter. The fast reaction is attributed to the microwave coupling of water bond for hydroxide complex cluster in an aqueous sheath, allowing like this an uniform heating of the whole solution. Rare-earth ions are used to dope perovskite-type oxides not only as a probe to investigate local centers and energy but also to provoke changes in the optical behavior or improve the capacitance response making possible to use these ceramics as high frequency ultrasonic transducers. Europium doped calcium titanate (CaTiO$_3$:Eu) micro-cubes-like powders were synthesized by hydrothermal microwave (HTMW) method with 0.5, 1.0 and 2.0% molar ratio of Eu$^{3+}$ ions. These materials were characterized by powder X-ray diffraction (XRD), FE-SEM images and room temperature photoluminescence spectroscopy.

CT:Eu-HTMW powders were synthesized mixing TiCl$_4$, CaCl$_2$,2H$_2$O and Eu$_2$O$_3$ in H$_2$O, and mineralized by KOH solution (6.0M). This mixture was loaded in a Teflon autoclave, which was sealed and placed in the Microwave-Hidothermal system and heated at 140°C for 10 min. Ca$^{2+}$, Ti$^{4+}$ and Eu$^{3+}$ hydroxides lose their OH groups enabling them to interact between Ti (network former) and Ca (network modifier) leading to CT:Eu precipitation. Thus, this can be described as the reason for qualifying the HTMW method as a typical bottom-up process for perovskite ceramics. Even under milder conditions the water viscosity is still low, it is plausible to assume that the mobility of dissolved ions are higher under hydrothermal conditions than normal ones, taking into account the increase of effective collision crash rate, producing irreversible oriented attachments during the hydrothermal microwave path. CT:Eu$^{3+}$ doped present the cubes-like morphology (Figure 1), so the spherical particles of the Eu$_2$O$_3$ are not observed, indicating that Ca$^{2+}$ are substituted by Eu$^{3+}$ in the CaTiO$_3$ lattice and no change is observed in the typical morphology of pure CT-HTMW compounds. The decay time of the Eu$^{3+}$ $^5D_0$-$^7F_2$ transition ($\lambda_{exc}$=394, $\lambda_{em}$=614 nm) fit one exponential curve (Figure 2) and is similar for all samples, indicating that only one type of Eu$^{3+}$ site is present in the CT framework.

References