The Effect of Aluminum Sources On $(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ Cubic Garnet Structure Synthesized by Co Precipitation Method

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Introduction

The multi-component cubic garnet $(Gd_{1-x}Lu_x)_3Al_5O_{12}$ structure attracts a lot of attention, making it the most popular in fields including as optics electronics. The one with the large Ln^{3+} cations is $(Tb_3Al_5O_{12})$. For eight fold coordination, the radius of the Tb^{3+} cation is 1.040. Because of its small ionic size (0.977 A°), lutetium is thought to be a stabilizer for the metastable $(Gd_3Al_5O_{12})$. According to the previous studies, GAG garnet can be stable at 1300°C when Gd is replaced with roughly 10% Lu and the radius of Ln :(Gd+Lu) is 1.0454. The Ln_2O_3–Al_2O_3 system is widely known to exist in three crystal phases: $LnAlO_3$ (LnAP with a perovskite structure), $Ln_4Al_2O_9$ (LnAM with a monoclinic structure), and $Ln_3Al_5O_{12}$ (LnAG with a cubic garnet structure) [1]. In conventional solid-state reactions, LnAG is far more stable than the other two intermediate phases. Chemical methods such as co-precipitation have been shown in numerous investigations to be effective in lowering the sintering temperature and obtaining pure LnAG powders [1]. The complicated structure and homogeneity of Gd^{3+}, Lu^{3+}, and Al^{3+} in the precursor for the synthesis of the pure (Gd,Lu)AG phase [1] at different temperatures with two different precipitation processes normal and reverse strike with two different aluminum sources $Al(NO_3)_3$ and $NH_4Al(SO_4)_2.12\ H_2O$ are discussed in this study.

EXPERIMENTAL SECTION

The samples $(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ were synthesized by co-precipitation method with normal (NS) and reverse strike (RS) processes, with aluminum nitrate $Al(NO_3)_3.9H_2O$ and aluminum ammonium sulfate $NH_4Al(SO_4)_2.12H_2O$ as aluminum sources. As a precipitant, ammonium hydrogen carbonate (AHC, NH_4HCO_3) was utilized. Concentrated rare-earth nitrate solutions were obtained by dissolving Ln_2O_3 (Ln: Gd and Lu) in hot nitric acid. Under room temperature, 100 mL of the nitrate solution (Gd+Lu+ Al) was added to 160 mL of the AHC precipitant solutionA stock solution of mother salts was produced from the nitrate solutions and aluminum using the formula $(Gd_{1-x}Lu_x)_3Al_5O_{12}$ (x=0.3). XRD is used to characterize $(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ nanoparticles in order to prove pure phase under various conditions.

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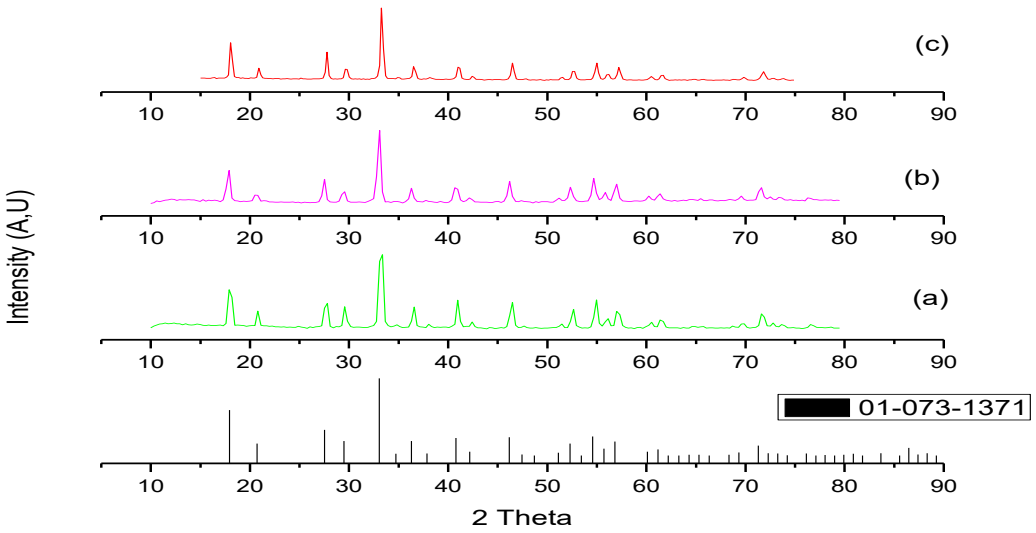

Fig.1: XRD patterns of $(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ calcined at , (a) 1150°C Nitrate $_{(RS)}$, (b) 1150°C sulfate $_{(NS)}$ and (c)1150°C sulfate $_{(RS)}$

RESULTS AND DISCUSSION

At various calcinations temperatures, XRD data indicate the pure phases of $(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ cubic garnets synthesized by co-precipitation. The pH values are the main difference between the two processes, normal and reverse strike. The powder X-ray diffraction data of $(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ reveals a near match with calculated patterns after Rietveld refinement. Because of the difference in crystallite size, we observed a minor shift in the lattice parameter. In order to reduce powder agglomeration, the sulfate aluminum source had a substantially lower agglomeration strength than the nitrate aluminum source [1,2].

CONCLUSION

$(Gd_{0.7}Lu_{0.3})_3Al_5O_{12}$ pure phases have been successfully synthesized used co-precipitation method. According to XRD analysis of the samples structures, the results achieved by $Al(NO_3)_3$ are better than NH_4AlSO_4 employed as an aluminum source for the preparation of GdLuAG precursor. The precipitates are completely different, when the cations are precipitated in both normal and reverse strikes processes of co precipitation method.

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