Synthesis And Luminescence of LiScCl₃:Ce

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Abstract. Luminescence in LiScCl₃ is reported for the first time. Intense emission of Ce³⁺ in this host was observed in UV region. This could be attributed to the transitions from the lowest excited state of 5d configuration to the ²F₅/₂, ²F₇/₂ split ground state of 4f⁰ configuration. Maximum intensity was obtained for Ce concentration of 1 mol.%, and luminescence was found to be quenched for higher concentrations.

INTRODUCTION

Lanthanide ions are very efficient activators. Due to the presence of shielded 4f shell, the energy levels can be predicted with relative ease. Interaction with the surrounding lattice is minimum and luminescence efficiency is high. For this reason, many important phosphors having various applications have been discovered which use lanthanide activators.

Luminescence intensity is limited by the phenomenon of concentration quenching. It is observed that the luminescence efficiency decreases if the activator concentration exceeds the specific value known as critical concentration. This effect is called as concentration quenching. When the concentration of the activator becomes so high that two activator ions come close enough to interact, the probability of energy transfer exceeds that for emission and the excitation energy hops from the one activator ion to the other and eventually lost at the surface, dislocations or impurities. Thus, it makes no contribution to the luminescence. The efficiency then decreases in spite of the increase of the activator concentration.

For obtaining efficient phosphors, it is important to find a suitable host for lanthanide activators which can accommodate these ions without concentration quenching. The hosts must be transparent to the emitted light. Lanthanides, most commonly occur as trivalent. Thus, hosts constituted by trivalent metals can be suitable. Yttrium compounds have been extensively studied as hosts.

Scandium is another trivalent metal. Compared to the yttrium compounds, Scandium compounds have been very scarcely studied as hosts. Apart from substituting lanthanide ion at Scandium site, Scandium can be inserted in stoichiometric lanthanide compounds which will again result in reduced concentration quenching [1]. In this paper we report, intense emission of Ce³⁺ in LiScCl₃ host. These are the first results on luminescence in this compound.

EXPERIMENTAL

The samples were prepared by wet chemical method described earlier [2]. Briefly, “LiScCl₃” was synthesized by dissolving the desired quantities of Lithium carbonate, Scandium oxide and Cerous oxalate in HCl. The excess acid was then boiled off and the solutions were evaporated to dryness. The resulting mass was dried at 475 K for 2 hours.
in air, crushed to fine powders (<72 microns). The powders were quickly sandwiched between quartz plates and transferred to photoluminescence (PL) cell. Photoluminescence spectra were recorded in the range 220-700 nm on a Hitachi F-7200 spectro-fluorimeter with spectral slit widths of 1 nm.

RESULTS AND DISCUSSIONS

Synthesis and crystal structure of LiScCl$_3$ was first described by Meyer’s group [3]. It belongs to monoclinic system, with space group C2/m, Z = 2. The lattice parameters are a = 639.8; b = 1104.0; c = 639.1 pm; $\gamma = 109.89^\circ$. Fig.1 shows unit cell of LiScCl$_3$. Both Li and Sc are six coordinated. The activator Ce$^{3+}$ is expected to occupy Sc$^{3+}$ sites.

Fig.2 shows results of PL measurements. Intense emission is observed in form of a band around 345 nm upon excitation by 320 nm. There is also a shoulder on the long wavelength side around 365 nm. The structure is typical of spin-orbit split ground state $^{2}F_{5/2}$, $^{2}F_{7/2}$ of Ce$^{3+}$ in 4f$^6$ configuration [4]. The excitation spectrum shows two clearly resolved bands around 280 and 320 nm. These arise from transitions between $^{2}F_{5/2}$, ground state and excited states belonging to the 5d$^1$ configuration. Inset shows concentration dependence of PL intensity. Height of 345 nm band is plotted as a function of Ce concentration. Maximum intensity was obtained for Ce concentration of 1 mol.%, and luminescence was found to be quenched for higher concentrations.

**FIGURE 1.** Unit cell of Li$_3$ScCl$_6$ showing anion coordination polyhedra

**FIGURE 2.** PL and PLE spectra of Li$_3$ScCl$_6$. Inset shows concentration dependence of PL intensity

CONCLUSIONS

New results on luminescence of Ce$^{3+}$ in Li$_3$ScCl$_6$ are presented. Li$_3$ScCl$_6$:Ce$^{3+}$ could be prepared by a simple wet chemical procedure. Ce$^{3+}$ emission is in UV region with a peak around 345 nm and a shoulder on the long wavelength side around 365 nm. The excitation band has a maximum at 320 nm. Maximum intensity is obtained for 1 mol.% Ce$^{3+}$ and concentration quenching takes place for higher values.

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REFERENCES