

EFFECT OF TRACE Bi^{3+} ON LUMINESCENCE OF Ce^{3+} IN $\text{CaS}:\text{Ce},\text{Bi}$

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We have measured the excitation spectra, time resolved luminescence spectra and decay curves of the sample $\text{CaS}:\text{Ce},\text{Bi}$. The effect of trace Bi^{3+} on Ce^{3+} luminescence and on the resonant transfer among Ce^{3+} ions in $\text{CaS}:\text{Ce},\text{Bi}$ are discussed.

1. INTRODUCTION

Cerium doped calcium sulfide is a green cathodoluminophors whose energy efficiency is as high as 20%. In order to improve further the luminescent properties of this material, to choose available sensitizers is important. For this purpose, the energy transfer of inter- and internal centers in $\text{CaS}:\text{Ce},\text{Bi}$ is investigated in this work.

2. EXPERIMENTAL

The samples with various dopant concentrations were prepared by the solid sulfurizing flux method reported elsewhere¹. The excitation and emission spectra were measured by a MPF-4 Fluorescence Spectrophotometer. The 266nm fourth harmonic pulses, with a half power width of 10ns and the repetition frequency of 5Hz, of a YAG laser were used to excite the sample in luminescence decay and the time resolved spectra measurements. The signals were recorded by a Bx-530 type Boxcar Integrator.

3. RESULTS AND DISCUSSION

The excitation spectrum of Bi^{3+} emission in $\text{CaS}:\text{Bi}$ consists of mainly three bands peaked at 280nm, 310nm and 410nm respectively. The last two are characteristic excitation bands of Bi^{3+} ion. For CaS doped with Ce^{3+} and trace Bi^{3+} , in the excitation spectrum of Ce^{3+} emission (monitoring at 570nm), compared with the excitation spectrum of Ce^{3+} emission in $\text{CaS}:\text{Ce}^{3+}$, two

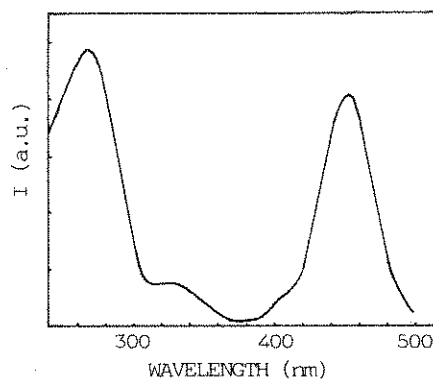


FIGURE 1
Excitation spectrum of Ce^{3+} emission in $\text{CaS}:\text{Ce},\text{Bi}$ (Ce^{3+} : 3×10^{-4} , Bi^{3+} : 5×10^{-5} ; monitoring wavelength: 570nm)

additional bands peaked at about 310nm and 410nm, which belong to Bi^{3+} , are observed (Fig. 1). It is a direct experimental evidence that the excitation energy may be transferred from Bi^{3+} to Ce^{3+} .

The life time of Ce^{3+} excited state is less than $1 \mu\text{s}$ ². The luminescence decay curve of Bi^{3+} in $\text{CaS}:\text{Bi}$ is composed of two components with the time constants of about 50 μs and 370 μs respectively, when the Bi^{3+} concentration being 5×10^{-4} . In $\text{CaS}:\text{Ce},\text{Bi}$, the decay of Bi^{3+} emission becomes faster, with a fast-component of 12 μs and a slow-component, 35 μs . In the sample we have found that the decay of Ce^{3+} emission is

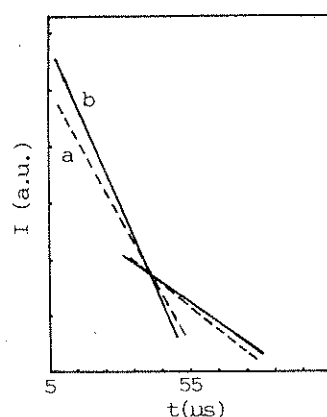


FIGURE 2
Decay curves of CaS:Ce,Bi for
(a) emission of Ce at 570nm and
(b) emission of Bi at 447nm

the same as that of Bi^{3+} , having a fast decay constant, 15 μs , and a slow one, 33 μs , as shown in Fig. 2. As increasing the concentration of Bi^{3+} , the decay for both Bi^{3+} and Ce^{3+} becomes faster. All these results imply that the excited energy absorbed by Bi^{3+} is transferred to Ce^{3+} and this energy transfer process is a nonradiative event.

Fig. 3 shows the time resolved emission spectra of CaS:Ce,Bi. An interesting result is obtained that the intensity of sub-bands of the Ce^{3+} emission changes differently with the delay time. As we know, these two sub-bands are due to the recombination from the same excited state ($5d$) of Ce^{3+} to its different ground states $2F_{5/2}$ and $2F_{7/2}$, respectively. The explanation of above results is given by proposing an idea of resonant transfer taking place only between the

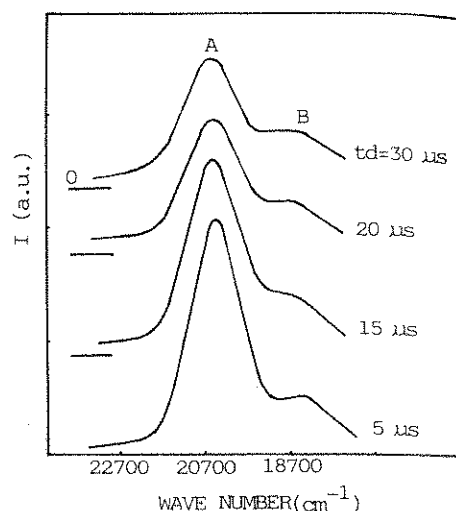


FIGURE 3
Time resolved spectra of CaS:Ce,Bi

transition $5d-2F_{5/2}$ which results in sub-band A. Both the Bi^{3+} and Ce^{3+} ions can be excited by the host excitation. Consequently, Bi^{3+} should compete with Ce^{3+} in getting the excitation energy from the host. On the other hand, we believe that the co-dopant Bi^{3+} probably may also affect the internal energy transfer among Ce^{3+} ions. The effect of trace Bi^{3+} on Ce^{3+} luminescence and on the resonant transfer among Ce^{3+} ions is discussed.

REFERENCES

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2. ZHOU Yingxue et al. Chinese J. Lumin. Vol. 7, No. 2, (1986) 171

1. INTRODUCTION

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2. MODEL

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