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Photochromism in CaS:Sm

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Abstract: The photochromism in CaS:Sm (from white to pink) was observed for the first time by exposing it to ultraviolet light. The experiments results show that the absorption intensity of Sm^{2+} in the range of 500~600nm was strongly increased after irradiation. This reveals that there is the valence changing of Sm. If the sample was excited by visible light again, the pink color turned to white, indicating that CaS:Sm has potential application in the field of storage material.

Keywords: Photochromism; CaS:Sm; valence transition; storage material.

CaS:RE has been known for a long time as an excellent phosphor[1]. The photochronism of SmS crystal[2] has been found. Yasuski[3] reported that Sm^{3+} ions traped electrons and changed into Sm^{2+} in the infrared stimulable phosphor CaS containing Eu and Sm ions, but photochromism has not been observed. In the present letter, the photochromism was observed in CaS:Sm.

Activated carbon, calcium sulfate, sodium sulfate and $Sm(NO_3)_3$ were mixed and ground, and then, the mixture was put into an alumia crucible and heated at 950°C for 3~4 hours. The samples were analyzed by x-ray diffraction technique with a Rigaku x-ray diffractometer (model D/max-B), showing that it is pure CaS crystallized in cubic structure[4]. Ultraviolet spectrometer (253.7 nm, 25 W) was used for irradiation of the sample. The emission spectrum and diffused reflection spectra (MgO was used as a standard sample) were detected by MPF-4 fluorescence spectrophotometer.

Results and Discussion

Under 253.7 nm irradiation, the body-color of CaS:Sm immediately becomes pink, indicating that phenomenon of photochromism occurs. In order to explain the mechanism of photochromism, the emission spectrum and diffused reflection spectra were measured and studied. From the emission spectrum (**Figure 1**), it can be seen that Sm^{3+} exists in the sample. The emission spectrum consists of three groups of emission lines located at

570, 606, 650 nm. These groups are respectively due to the transitions from the $^4G_{5/2}$ state to the ^6H_J (J=5/2, 7/2, 9/2) states in the Sm^{3+} ion.

Figure 2 shows the diffused reflection spectra of the sample. The broad absorption bands at about 530 nm and 580 nm were strongly increased after irradiation. It is the absorption of Sm^{2+}[5]. After irradiation the body-color becomes pink that will keep on by avoiding visible light. But if the sample is excited by visible light again, it returns to white. This character of CaS:Sm may lead to the application in the storage material. However, the storage character of the sample is not clear. Further study is in progress and will be reported in the future.

Figure 1. The emission spectrum of CaS:Sm

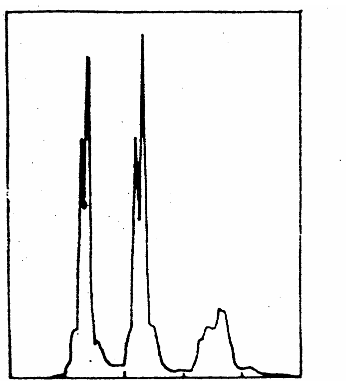
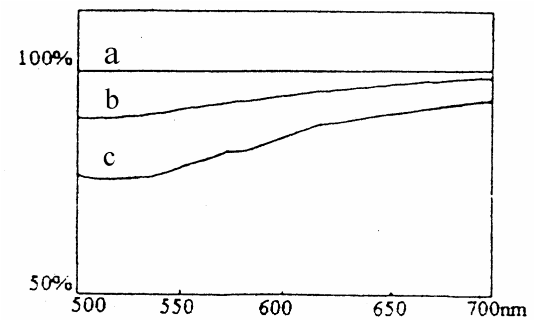


Figure 2. The diffused reflection absorption spectra of CaS:Sm. (a) MgO, (b) Before irradiation, (c) after irradiation (30min)



The results mentioned above reveal that there is valence changing of Sm by exposing the sample to the ultraviolet light. A possible process is that an electron of S^{2-} is excited[2] during irradiation, and then, Sm^{3+} captures the electron and changed into Sm^{2+}. The body-color becomes pink. If avoiding visible light, the state of Sm^{2+} is stable, otherwise the electron would be lost and Sm^{2+} be changed to Sm^{3+} again. The body-color also returns to white.

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