

# THE SPECTRAL CHARACTERISTICS OF SAMARIUM IN FUSED QUARTZ

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UDC 543.42:546.659

We have made a spectral study of fused quartz containing impurity samarium ions. The absorption and luminescence spectra were recorded at room temperature, at liquid nitrogen, and at helium temperatures. The luminescence kinetics at room temperature and liquid nitrogen temperature were also recorded. The spectral characteristics showed no significant change from room temperature to liquid helium temperatures.

The absorption spectrum consists of several very wide overlapping bands with a maximum at  $\sim 3600 \text{ \AA}$  (Fig. 1). When the specimen is excited in the absorption region, the spectrum displays a bright red luminescence which consists of a series of bands with each band characterized by a half-width of  $\sim 100 \text{ \AA}$ . In addition

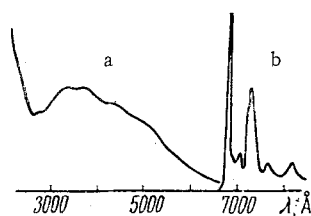


Fig. 1

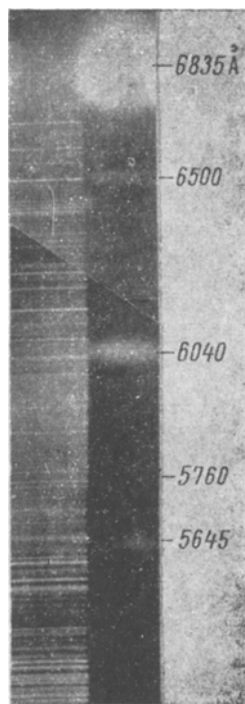


Fig. 2

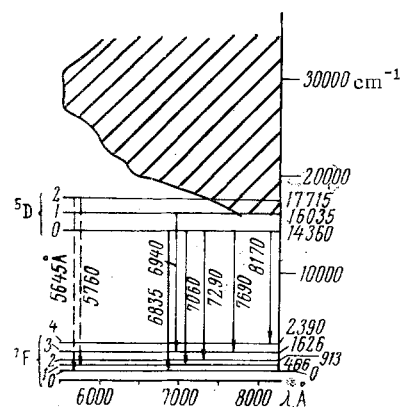


Fig. 3

Fig. 1. Spectral characteristics of  $\text{Sm}^{2+}$  in fused quartz: a) absorption spectrum at room temperature (300°K); b) luminescence spectrum (77°K).

Fig. 2. The low intensity luminescence spectrum of samarium in fused quartz (77°K).

Fig. 3. Energy level diagram for  $\text{Sm}^{2+}$  in fused quartz.

Translated from Zhurnal Prikladnoi Spektroskopii, Vol. 11, No. 1, pp. 175-176, July, 1969. Original article submitted December 8, 1968.

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to the most intense band with a maximum at 6835 Å which is responsible for the visible luminescence, Fig. 1 also shows bands in the near infrared region: 6940 (weak), 7060, 7290, 7690, 8170 Å.

The initial region of the attenuation curve at a wavelength of 6835 Å does not change exponentially and its analysis is made difficult by the long duration of the excitation impulse ( $2.5 \cdot 10^{-5}$ ). The final stage of luminescence is exponential with  $\tau = 1.4 \cdot 10^{-3}$  sec at room temperature, and  $\tau = 1.9 \cdot 10^{-3}$  sec at the boiling point of liquid nitrogen.

A comparison of these results among themselves and with the data from [1-4] suggests that the samarium is in a divalent state. The luminescence then is produced by forbidden transitions within the  $4f^6$  configuration between the  $^5D$  levels and the components of the fundamental  $^7F$  multiplets, while the absorption is due to allowable transitions from the fundamental  $^7F_0$  state to the mixed configuration level  $4f^55d$ .

With long exposures it is possible to record a narrower line at 6500 Å and, using photosensitive materials insensitive in the red region but sensitive in the appropriate region, faint lines at 6040, 5645, and 5760 Å were successfully photographed (Fig. 2). The low intensity of these lines may be due, among other things, to reabsorption.

Figure 3 shows the diagram of the levels which we attribute to divalent samarium in quartz. There is some doubt about the position of the  $5D_2$  level which is determined from the lines at 5645 and 5760 Å. These lines may be attributed to the  $^5D_2 \rightarrow ^7F_0$  and  $^5D_2 \rightarrow ^7F_1$  transitions on the one hand as in [4], or on the other, to the luminescence of the trivalent samarium impurity. The latter is more likely. This is indicated by the presence of lines at 6040 and 6500 Å and also by the absence of the temperature dependence of the intensity of these lines that was observed in [4].

The authors wish to thank M. E. Zhabotinskii and Yu. P. Rudnitskii for useful discussions and for their assistance with the work.

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