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Polarization of Photo- and Radio-Photo-Luminescence of a Silver-Activated Borate Glass

Toru KISHII

Central Research Laboratory, Tokyo Shibaura Electric Co., Kawasaki

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There have been observed polarizations of fluorescence of uranyl-activated glasses[1] and of radio-photo-luminescence of a silver-activated phosphate glass[2] by excitation with polarized ultra-violet light. The values of the degree of polarization $P=(I_{\parallel}-I_{\perp}/I_{\parallel}+I_{\perp})$ reached in these two cases were about 0.25 and 0.21, respectively. Here $I_{\parallel}$ and $I_{\perp}$ are the polarized components of the luminescence with electric vectors parallel and perpendicular, respectively, to the electric vector of the polarized exciting light.

In this report, the polarization of luminescence in a silver-activated borate glass was investigated, the value of P observed being about 0.48. The composition of the glass was B_2O_3 68, Na_2O 14, Al_2O_3 8 and Ag_2O 10 in weight %. The glass was melted from reagent grade chemicals (HBO_3, $Al(OH)_3$, Na_2CO_3 and Ag_2O) within an alumina crucible in a gas-fired furnace. Polarization was measured on a polished sample of the glass with the apparatus already reported (shown on the right side of Fig. 1 in ref. 2). Various

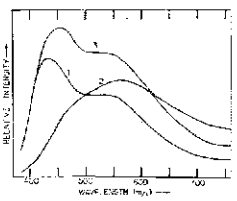

Fig. 1. Fmission spectra of the glass sample by excitation with 365 mμ line of mercury 1. before irradiation, 2. after irradiation by γ-ray of Co^{60} (1.3×10^5 *r/hr*, 48 *hr*) and 3. after irradiation and successive heating at 400°C for 30 min

combinations of filters and monochromator were used for obtaining both the exciting light (from 100 W super high pressure mercury lamp) and the fluorescent light. The sample was subjected to γ-ray irradiation from Co^{60} (1.3×10^5 r/hr) and then to successive heat treatments. Duration of each heat treatment was 30 min. Emission spectra of the glass are shown in Fig. 1. Emission or absorption spectra of silver centers in alkali halides or Mg-borate phosphor are reported in ref. 3 and 4, respectively.

Change of the degree of polarization P was plotted in Fig. 2 against the irradiation time and the temperatures of heat treatments. The value of P increased with increase of irradiation dose and restored again by heating. Polarization was more distinct by excitation with light in longer wavelength region and for fluorescent light of shorter wavelengths.

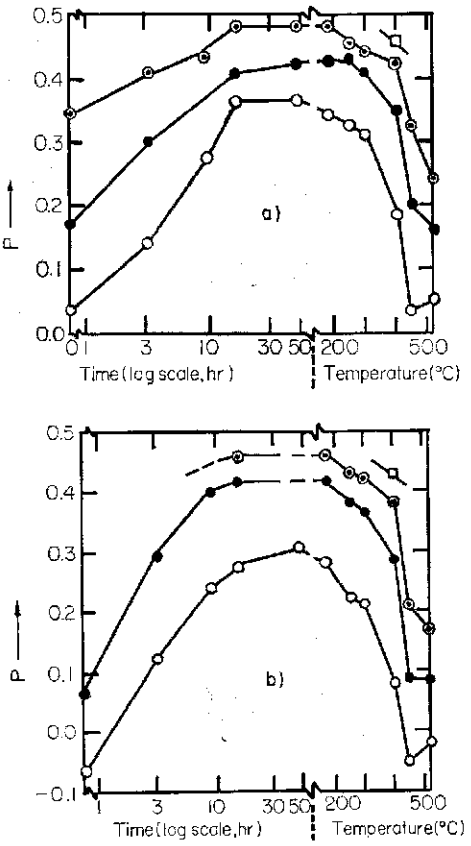

Fig. 2. Change of degree of polarization P with irradiation time and temperatures of successive heat treatment for fluorescent light between a) 490~600 mμ (V—G54 filter) and b) 540~600 mμ (V—G54+V—O56 filters) Main lights for excitation are; ○: 365 mμ (UV—D2 filter), ●: 405—408 mμ (V—V40 filter), 436 mμ (V—V40+KL—44 filters)and □: 436 mμ (monochromator).

Complex natures of the fluorescent centers in a silver-activated glass were noted by Yokota *et al.*[5] If the centers in an amorphous medium such as glass are equivalently represented by electric dipole oscillators having an isotropic orientations and parallel emitting and absorbing oscillators within each center, P of 0.5 is expected. Actually, the value of P observed was 0.48 and was very near to the value noted above.

Possible causes of such a distinct polarization of the luminescence are, for example; 1, anisotropic structure of the centers such as $Ag^{\circ}\cdot Ag^{\circ}$[5], 2, severe deformation of glass structure accompanying the formation of the centers by the reactions such as $Ag^{+}+e^{-}\rightarrow Ag^{\circ}$ or $Ag^{\circ}+Ag^{\circ}\rightarrow Ag^{\circ}\cdot Ag^{\circ}$ and 3, resultant or inherent asymmetry of electric field around the centers. Detailed study on silver centers in glass is now in

progress by R. Yokota in this laboratory. The author wishes to express his sincere thanks to Dr. Y. Uehara, who kindly took a trouble to measure emission spectra shown in Fig. 1.

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