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The inherent memory effects based on hysteresis behaviors in ac electroluminescent (EL) characteristics have been found in ZnS:Mn thin-film EL devices.

The experimental device is in a multilayered structure, as shown in Fig.1, with  $Y_2O_3$  insulating layers on both sides of a ZnS:Mn EL film. The EL and the insulator films were prepared by electron-beam evaporation, respectively. High-purity ZnS pellets doped with Mn up to 5 wt.% were used as a source material for the deposition of EL film.

The dependence of EL brightness (B) on voltage (V) for the temperature at 300°K and 77°K under square-wave ac excitation, traced on an X-Y recorder, are shown in Fig. 2. Here, typical hysteresis behaviors in increasing and decreasing process for the amplitude of applied voltage is observed. The figure shows that the B-V hysteresis loop tends to broaden out considerably together with greater increase in threshold voltage ( $V_{th}$ ) for EL emission as the temperature decreases.

As shown in Fig.3, it is interesting to note that the B-V hysteresis loop varies continuously for the applied voltage above  $V_{th}$ , rendering the unrestrictive static states in EL and electrical characteristics to exist within the hysteresis loops. Therefore the memory effects based on the B-V hysteresis mentioned above are apparently equivalent to an analog memory function.

Fig.4-a and b demonstrate the memory operation with writing and erasing sequence by square-wave excitation. The ON state EL brightness ( $B_s$ ) for a sustaining voltage ( $V_s$ ) can be chosen continuously between the OFF state brightness ( $B_e$ ) and the maximum ON state brightness ( $B_{sm}$ ) by varying the amplitude of the writing voltage ( $V_w$ ). Existence of similar memory operation by optical means was also confirmed, as shown in Fig.5. In the experiment the EL layer was irradiated with UV light or He-Ne laser beam during ac excitation for optical writing process.

From these results it is obvious that the B-V hysteresis also enables such imaging operation as to realize continuous readout display of a stored latent image with gray scale depiction in accordance with the field-assisted photo-polarization effects (1).

Fig.6 shows the rms field intensity across the ZnS:Mn film and also the conduction current corresponding to the EL emission intensity as a function of the applied voltage calculated from the I-V relationship for sinusoidal excita-

tion. It is seen that an abnormal drop of the ZnS field occurs at  $V_{th}$  accompanied by the abrupt increase of the conduction current, thereafter followed by sluggish rise of the field intensity for higher applied voltage. These effects are also supported by the current waveform observed at the external terminals of the device under triangular ac excitation, as shown in Fig. 7. When the device is in the ON state, the induced conduction current is superimposed on the displacement current.

Reference : (1) C. Suzuki, Y. Kanatani, M. Ise and E. Mizukami, Tech. Group on Electron. Device, Inst. Electric. Eng. Jap., Paper(in Japanese)EDD-73-93 (1973)

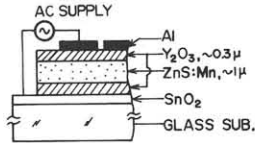


Fig.1 Device structure.

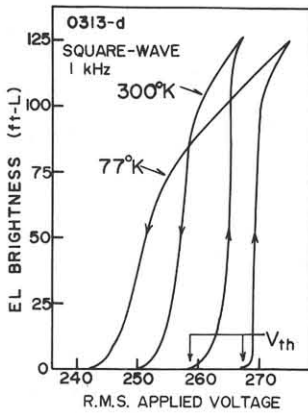


Fig.2  
B-V relationship.

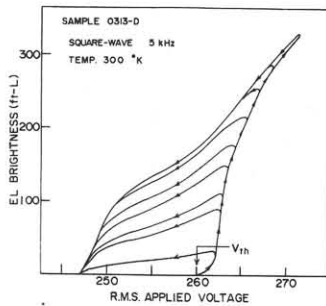


Fig.3  
B-V hysteresis behaviors.

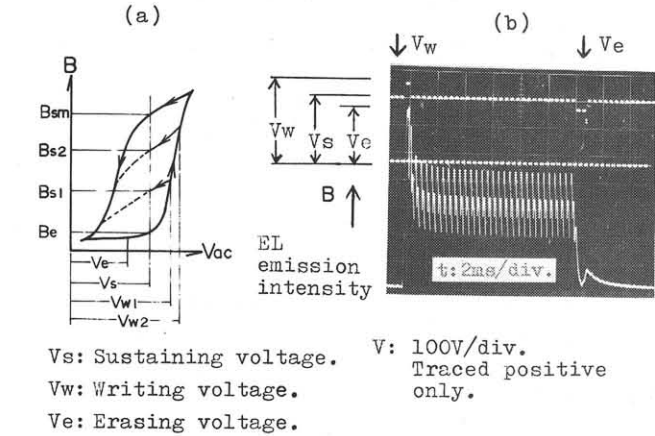


Fig.4 Memory operating characteristic.

Fig.5  
EL display  
by optical  
writing process

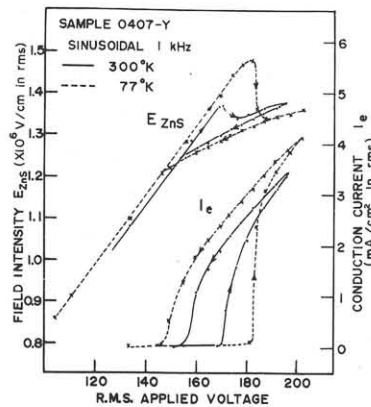
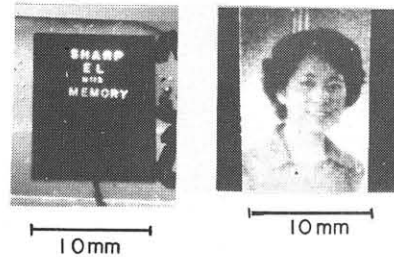


Fig.6  
ZnS field intensity &  
current vs. applied voltage.

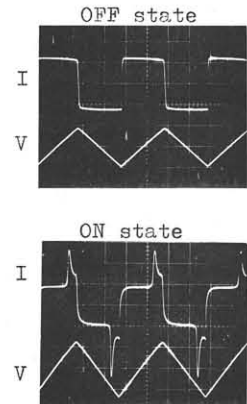


Fig.7 V: 200V/div.  
I: 0.1mA/div.  
t: 0.5ms/div.