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# GaAs Light Coupled Device

Z. Tani, K. Murata, T. Sakurai and T. Inoguchi
Central Research Lab., SHARP Corporation
TENRI, NARA

Charge Coupled Device (CCD) and Plasma Coupled Device (PCD) as functional devices for shift-resistor were proposed some time ago and have been developed. Each of the elements in these devices were coupled by electric charge and the plasma state, respectively. This paper proposes a device which performs similar functions as the CCD or PCD whose elements are coupled to each other by means of light.

Construction Previously, the GaAs PNPN diode which was made by a single process of liquid phase epitaxial growth doped with silicon alone was published. As well known, the switching voltage Vs of this diode is reduced by the incident light. However, the incident light is reduced in intensity that result in little effect upon Vs due to surfase reflection. On the other hand, a marked effect on Vs is observed due to the light generated from the diode within the same substrate. The GaAs LCD is composed of an array of GaAs PNPN diodes fabricated on the single GaAs wafer. These diodes are electrically isolated by mesa-etch but optically coupled to each other. Fig.1 shows the current-voltage characteristic of one element of the GaAs LCD. Curve (a) was observed when the adjacent diodes are on the OFF state, and curve (b) was observed when the adjacent diode was on the ON state, which show that Vs is reduced by the light that comes from adjacent element.

GaAs LCD line scanner The schematic structure of this devices is shown in Feg.2. The scanning procedure is as follows; (1)$V_1$=0 volt, $V_2$=Va (Va<Vs) and $V_3$=0 volt. Assume that diode "3" is on the ON state and others are on the OFF state. (2)$V_1$=0 volt, and $V_2$=$V_3$=Va. Diode "3" continues to be on the ON state and diode "4" switches to the ON state by the light from the adjacent diode "3". Others are on the OFF state. (3)$V_1$=$V_2$=0 volt and $V_3$=Va. Diode "3" switches to the OFF state and diode "4" is on the ON state and others are on the OFF state.
By repeating the above mentiond procedures, the ON state, i.e. the lighting spot, can be transferred to the adjacent element. If the voltage Va is applied one after another to $V_1$, $V_2$ and $V_3$ as in Fig. 3, the ON state, i.e. the light spot, is made to scan. Fig.4(a) is a photograph of the LCD line scanner with 7 elements mounted on the multi-laminated package and (b) is the photograph of this device, showing one element on the ON state and others on the OFF state which was taken under the infra-red microscope. The scanning velocity is limited by two characteristic of the element; (1) the turn on and turn off time which is 0.5 - 3.0 μ-sec. and (2)

the dependence of Vs upon (dV/dt) shown in Fig. 5. This dependence can be seen within the holding current of less than 5 mA. In the GaAs LCD line scanner whose elements had the holding current of 2-3 mA, the maximum scanning velocity of about $2.5 \times 10^4$ elements/second was observed.

GaAs LCD logic circuit Fig.6 (a), (b) and (c) are indicative of logic circuits which may be realized by LCD. The number 1, 2 and 3 in "□" indicate that these elements are applied with bias voltage of $V_1$, $V_2$ and $V_3$, respectively.

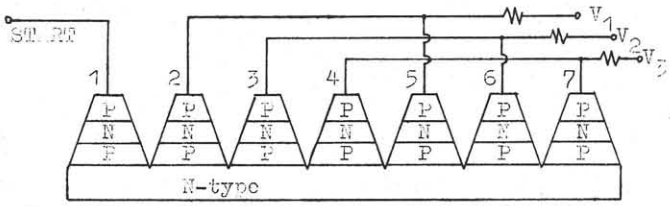



Fig.2 The schematic construction of the LCD array

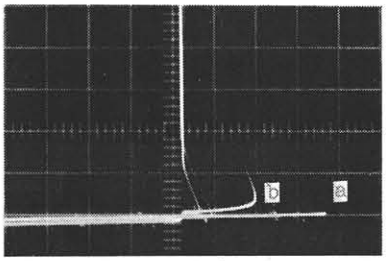



Fig.1 H: 5 V/div.
V: 2 mA/div.

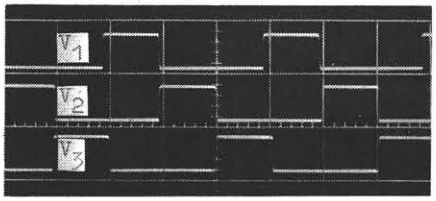



Fig.3 H: 1 msec/div.
V: 20 V/div.

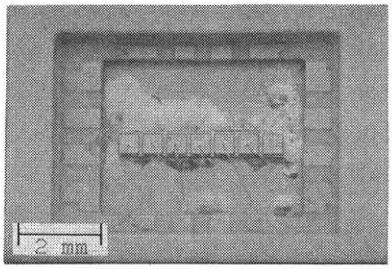



Fig.4 (a)

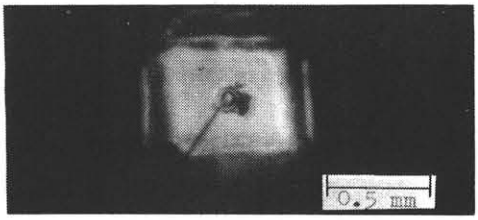



Fig.4 (b)

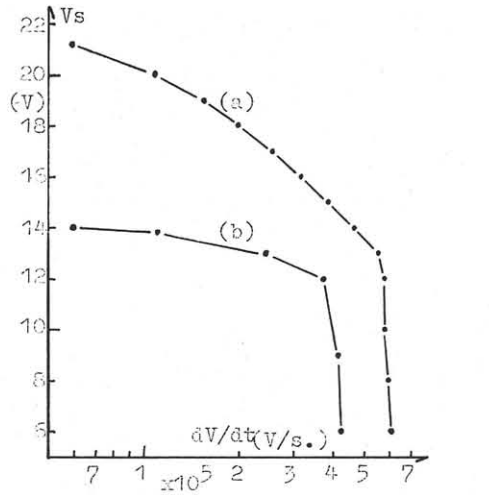



Fig.5 Vs vs dV/dt characteristic
(a):no illumination (b):illumination.

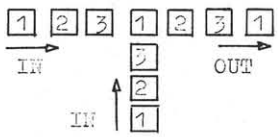
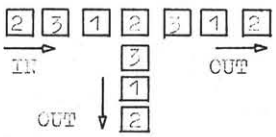
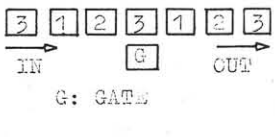



Fig.6 (a) AND, OR circuit.




(b) NOR circuit.




(c) GATE circuit.