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A3-3 Graded-Composition Chalcogenide-Glass Photodiode

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A new type of T.V. pickup tube target was developed recently, using a large-area chalcogenide-glass diode (CGD).[1),2)] The principal features of the CGD target are low dark current, fast photo-response, high resolving power, little flare and well-balanced spectral sensitivity for color T.V. use.

This pickup tube was named "Saticon" because the main part of the target was composed of Se-As-Te chalcogenide glass; and the construction of the Saticon target was characterized by the graded distribution of Te concentration.

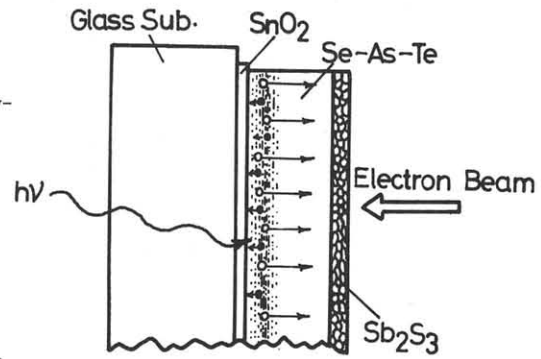

Fig.1 Schematic construction of the Saticon target.

We are going to report here the effect of the Te distribution on the current-voltage characteristics of the Saticon and also the proposed band-model for the graded-composition CGD.

Figure 1 shows a schematic construction of the Saticon target. An Se-As-Te layer is deposited on an SnO_2 transparent electrode formed on a glass substrate. The thickness of the chalcogenide glass layer is about 4 μm, and the Te concentration is expressed by the concentration of short streaks in the figure. The chalcogenide glass layer is covered by a porous Sb_2S_3 layer in order to prevent secondary electron emission due to the scanning electron beam.

Compositional analysis by means of an ion probe micro-analyser was carried out; the result is shown in Fig. 2. The figure shows only the first several thousand angstrom part of the layer.

The role of Se component is to secure diode characteristic, that of As is to prevent crystallization of Se-rich chalcogenide glass and that of Te is to obtain enough photosensitivity for longer wave lengths. Since Te and As both cause

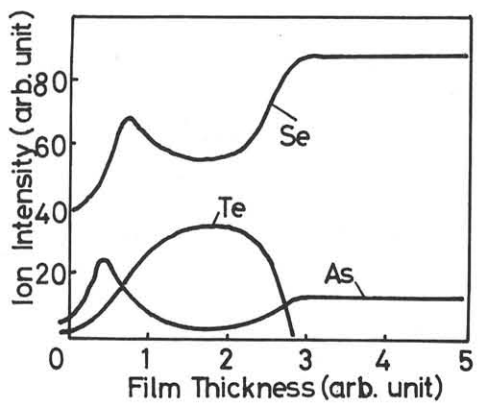

Fig.2 Ion microprobe analysis of the graded-composition structure.

the degradation in carrier transport in amorphous Se, the target structure shown in Fig. 2 is necessary in obtaining low dark current, fast response and higher sensitivity for red light, at the same time.

Figure 3 shows photocurrent-voltage characteristics of CGD for a shorter wave length. The graded-Te-composition diode has a characteristic threshold voltage for the up-rising of the photocurrent, whereas the diode without Te shows slow increase of the photocurrent along with the increase of the applied voltage.

The origin of this threshold voltage is attributed to the field-dependent lifetime of photo-generated carriers in the chalcogenide glass. The Te-rich region may form a low-field and narrow-band-gap layer, and most of the incident light is absorbed in this region.

One should be careful in the band-model treatment of amorphous semiconductor, since the existance of energy band itself in the sense of crystalline semiconductor is not fully confirmed in general amorphous materials.

Capacitance-voltage characteristic, temperature dependence of forward and reverse current, and time dependence of photocurrent of CGD are examined; and we think we have good reason for proposing a band model of a graded-composition CGD as shown in Fig. 4.

The similarity of amorphous Se to crystalline semiconductors such as impurity-sensitive transport will also be presented in the Conference.

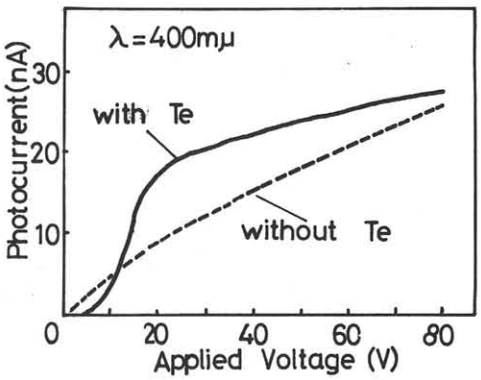

Fig.3 Photocurrent-voltage characteristics of CGD with and without graded-Te concentration.

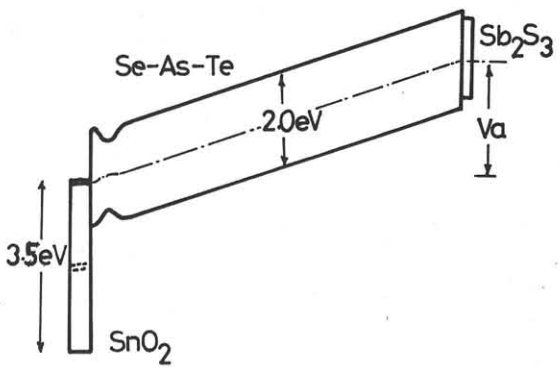

Fig.4 Proposed band-model for the graded-composition CGD.

References

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2) N.Goto, Y.Isozaki, K.Shidara, E.Maruyama, T.Hirai and T.Fujita: to be published in Trans. IEEE.