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B−1−3 Platinum Silicide Schottky-Barrier IR-CCD Image Sensors

M.KIMATA, M.DENDA, T.FUKUMOTO, N.TSUBOUCHI, S.UEMATSU,

H.SHIBATA, R.HIGUCHI, and T.SAEKI

Mitsubishi Electric Corporation

4-1,Mizuhara, Itami, Hyogo, 664, Japan

R.TSUNODA, and T.KANNO

Technical Research & Development Institute, Japan Defence Agency

2-2-1, Nakameguro, Meguro, Tokyo, 153, Japan

Because of utilizing standard silicon LSI wafer processes, silicon Schottky-Barrier Infrared Charge Coupled Device (S.B. IR-CCD) focal plane has many advantages to produce a large scale monolithic IR image sensor. The main problem of S.B. IR-CCD is rather low responsivity in comparison with the IR image sensor using a narrow gap compound semiconductor. We describe a new structure of the platinum silicide (PtSi)/p-type Si S.B. detector which shows higher responsivity, and the operation and performance of a 64x32 monolithic IR-CCD with the new structure.

Fig.1 shows two structures of S.B. detector. Type A is a conventional structure, and Type B is a new one with no metal (TiW or Al) above the detector.

The photoyield, Y, for Schottky emission is given by[1)]

$$Y = C_1 \frac{(h\nu-\Psi ms)^2}{h\nu} \quad \text{(electrons/photon)}$$

where Ψ ms is the barrier hight, h is Plank's constant, ν is the photon frequency and C_1 is quantum efficiency coefficient.

The comparison of the photoyield between Type A and Type B is shown in Fig.2, where the thickness of PtSi is 9 nm. Ψms of both types was almost the same value, that is 0.26 eV (λ_{cutoff}=4.8 μm), but C_1 of Type B was about 4.6 times as great as that of Type A.

Fig.3 shows the C_1 vs. PtSi thickness. As reported by R.Taylor et al.[2)], in case of Type A, the improvement of C_1 was about factor 2 when PtSi thickness was reduced from 90 nm to 15 nm, but that of Type B was about factor 6.7. This remarkable improvement is considered to be caused by the carrier reflection effect at the back wall (PtSi-SiN interface).

Fig.4 shows a photomicrograph of the 64x32 PtSi S.B. IR-CCD with the detector of Type B. Each detector is 2020 μm^2 in size and spaced on 80 μm center vertically and 133 um center horizontally. Total chip size is 6.17x7.12 mm^2. The device utilizes double polysilicon buried channel CCD's with an interline transfer format.

The transfer charactristic of the array is shown in Fig.5. The source of the measurement was a blackbody held at 500 K or 1000 K. In both cases, good linearity was obtained within about three orders. The responsivity for 1000 K target was about 10 times as high as for 500 K.

Fig.6 shows an example of thermal image obtained with the array using 66 msec stare time and a 57 mm f/1.0 optics. The photograph has been made without any external correction of imaged signal.

References:

[1] F.D.Shepherd et al., Advances in Electronics and Electron Physics, Vol. 40B (1976) pp.981.

[2] R.Taylor et al., SPIE's Technical Symposium, Advanced in Focal Plane Technology, Los Angels, CA, Feb., Vol. 217 (1980) pp.103.

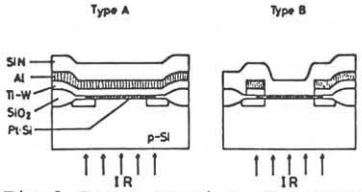

Fig.1 Cross Section of S.B.detector

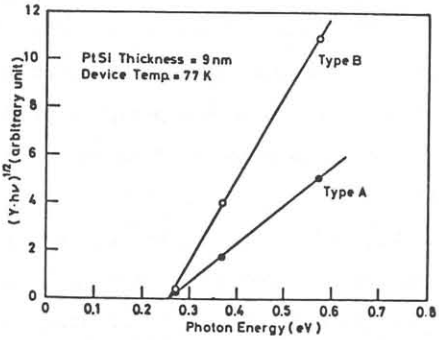

Fig.2 Photoyield vs. Photon Energy

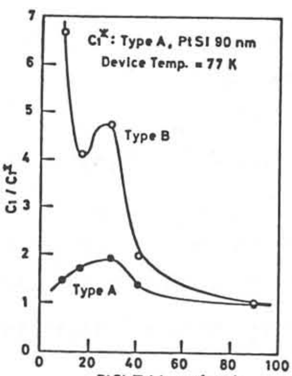

Fig.3 C_1 vs. PtSi Thickness

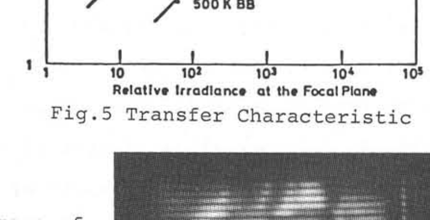

Fig.5 Transfer Characteristic

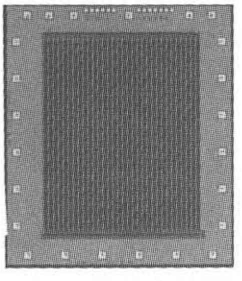
Fig.4 Photomicrograph of S.B. IR-CCD


Fig.6 Thermal Image of a Human Face