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A — 3 — 7 "HIGH-PERFORMANCE SCHOTTKY-BARRIER IR-CCD IMAGE SENSORS" (Invited)

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High-performance PtSi and Pd_2Si Schottky-barrier (SB) IR-CCD image sensors were recently developod.[1-3] These monolithic focal plane arrays (FPAs) are attractive for many thermal and short-wavelength infrared (SWIR) applications.

The SB FPAs developed at RCA Laboratories are summarized in Table 1. These arrays were fabricated as two-level polysilicon n-type buried-channel CCDs with PtSi and Pd_2Si SB detectors. The 25 x 50, 32 x 63, and 64 x 128 interline-transfer FPAs have detector-area efficiencies (fill factors) of 17, 25, and 22%, respectively. Fill factors approaching a value of 50% are expected in the next generation of higher density SB FPAs.

The crossectional view of the recently developed "thin" high-performance PtSi SB detectors is illustrated in Fig.1. In this structure a very thin and very uniform layer of PtSi, formed on the p-type silicon substrate, is separated from an aluminum reflector by a layer of a deposited SiO_2 dielectric. The optimal thickness of the silicide layer is in the range of 20 to 100Å, while that of the SiO_2 layer is in the range of 2000 to 6000Å. The resistivity of the p-type silicon substrate is in the range of 30 to 50 ohm-cm. The performance of a 25 x 50 FPA with such "thin" PtSi SB detectors was described in 1980.[1]

Responsivity and quantum efficiency (Q.E.) measured as a function of wavelength of the high-performance PtSi and Pd_2Si SB detectors is shown in Fig.2. The devices 11H and 2M (see Figs.2 and 3) represent two types of PtSi SB detectors. One has a higher quantum efficiency and the other is more tolerant to temperature variations. Note, that for the PtSi detector 11H-75 operated at a temperature of 80K, quantum efficiencies of 4.0 to 1.0% in the spectral range of 3 to 4.5 μm and cut-off wavelength in excess of 6.0 μm were achieved. The Pd_2Si detectors operated at a temperature between 120 and 140K have cut-off wavelength of 3.6 μm and quantum efficiency in the range of 1.0 to 8.0% in the SWIR band. The measured dark (leakage) current characteristics as a function of temperature of the above of PtSi and Pd_2Si SB detectors are shown in Fig. 3. The dark current density as a function of the reverse bias voltage for the two types of PtSi SB detectors is shown in Fig.4.

The quality of thermal imaging obtained with a 64 x 128-element PtSi IR-CCD TV camera is illustrated in Fig.5. The PtSi FPA is operated in a liquid nitrogen Dewar at about 80K with the frame rate of 60 f/s and f/1.5 germanium optics. Additive type of electronic compensation was used to correct for small variations in the dark current of the PtSi SB detectors.

References

1. W. F. Kosonocky, et al, "Advances in Platinum-Silicide Schottky-Barrier IR-CCD Image Sensors," SPIE Vol. 225, IR-Image Sensor Technol. (1980), pp. 69-71.
2. W. F. Kosonocky, et al, "64 x 128-element High-Performance PtSi IR-CCD Image Sensor," 1981 IEDM, Washington, DC, Dec. 7, 1981.
3. H. Elabd, et al, "Palladium-Silicide Schottky-Barrier IR-CCD," IEEE Electron Device Letters, 3, April 1982.

Type of FPA	Chip Size $(mil)^2$	Pixel Size $(\mu m)^2$	Fill Factor	Type of SBD	Year
256 x 1 Line Sensor	438 x 71	40 x 200	50% 78%	Thick PtSi Thin PtSi	1977 1979
25 x 50 Interline Transfer	230 x 230	160 x 80	17%	Thick PtSi Thin PtSi	1978 1979
32 x 63 SPS IT	265 x 265	160 x 80	25%	Thin PtSi Thin Pd_2Si	1980 1981
64 x 128 SPS IT	364 x 364	120 x 60	22%	Thin PtSi Thin Pd_2Si	1981 1982

Table 1. SB FPAs developed at RCA.

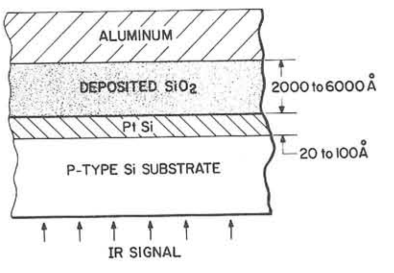

Fig.1. High-performance PtSi SB-detector structure.

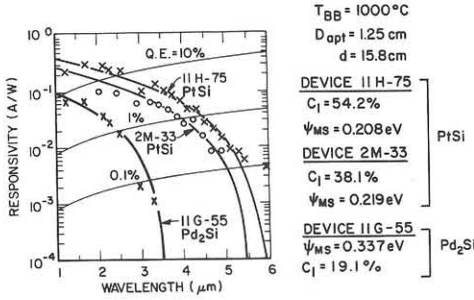

Fig.2. Measured responsivity and Q.E. of PtSi and Pd_2Si SB detectors.

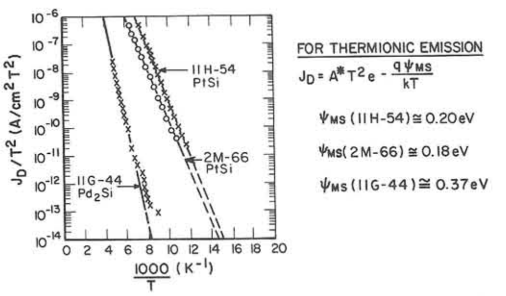

Fig.3. Dark current vs. temperature of PtSi and Pd_2Si SB detectors.

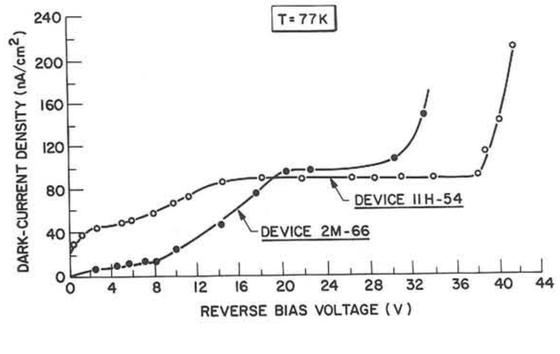

Fig.4. Dark current density as a function of bias voltage for PtSi SB detectors.

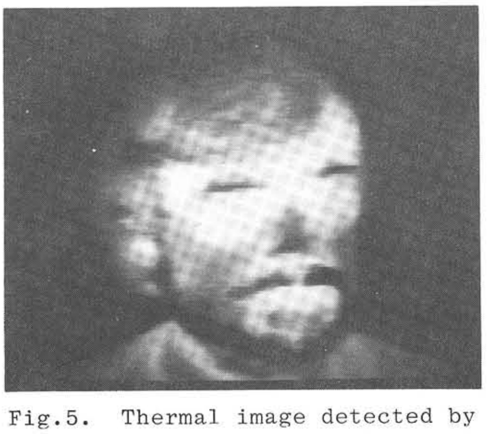

Fig.5. Thermal image detected by 64 x 128 IR-CCD TV camera.