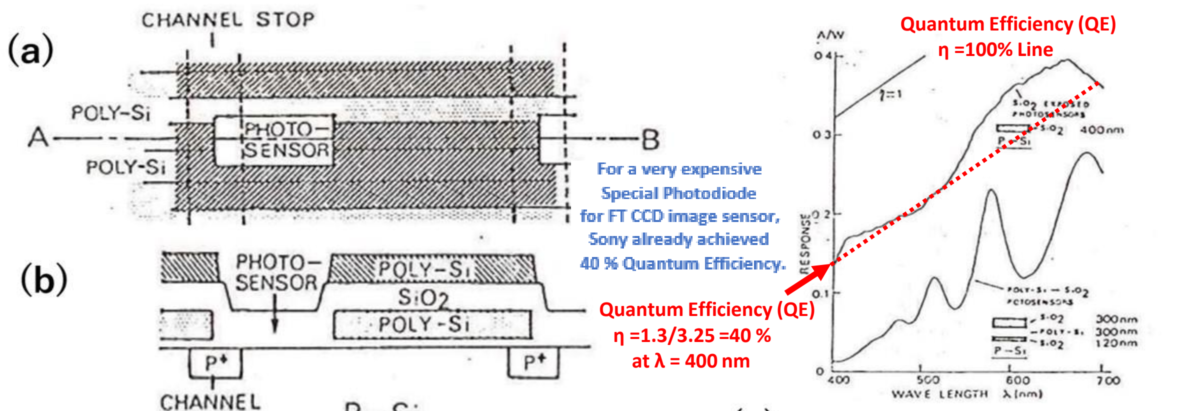
“Frame Transfer CCD Image Sensor with SiO2 exposed sensor array” by Sony in 1977

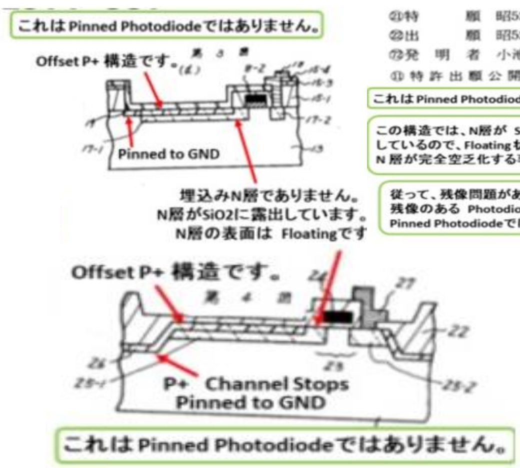


(c) Spectral response of the photosensors

(5) T. Shimada, S. Koyata, C. Okada, S. Koito, M. Futagami, M. Abe, T. Ando, and Y. Kanoh, "Frame transfer CCD image sensor with SiO_2 exposed sensor array" (in Japanese), in Prof. Group Semicond. Semicon. Device of Inst. Electron. Commun. Eng. Japan, vol.SSD-77, no.2, 1977.

Hitachi 1977 Photodiode structure is NOT identical with Sony 1978 Pinned Photodiode.

Hitachi JPA1977 -837 Patent



㉑特 願 昭52—837
㉒出 願 昭52(1977) 1 月10日
㉗発 明 者 小池紀雄
⑪ 特 許 出 願 公 開 昭53—86516

これはPinned Photodiodeではありません。

この構造では、N層が SiO2 表面に露出しているので、Floating 状態となり完全に N 層が完全空乏化する事はありません。

従って、残像問題がある構造です。残像のある Photodiode は決して Pinned Photodiodeではありません。

SONY SSDM1978 Paper

Proceeding of the 10th Conference on Solid State Devices, Tokyo, 1978;
Japanese Journal of Applied Physics, Volume 18 (1979) Supplement 18-1, pp.335-340

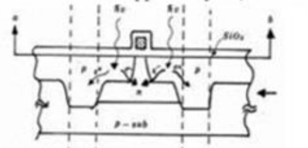


Fig.3 Crosssectional view of the Narrow Channel Transfer Electrode with the SiO2 exposed Pinned Window and the Pinned Photodiode P+ surface.

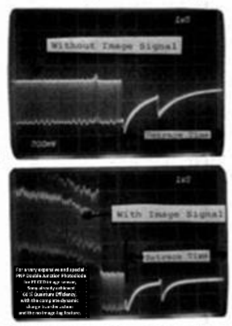


Fig.12 Comparison of the Pinned Photodiode image sensor with and without image signal gives the very low dark current level at retrace time.

PNP Double Junction Photodiode
for FT CCD image sensor,
Sony already achieved
60 % Quantum Efficiency,
with the complete dynamic
charge transfer action
and the no image-lag feature.

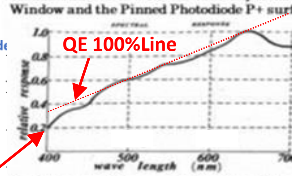


Fig.13 Spectral Response of the Pinned Photodiode with Pinned SiO2 Window and Pinned Surface.

Sony achieved in 1978 QE = 0.20/0.33 ＝60% at λ=400nm

THE PINNED PHOTODIODE FOR AN INTERLINE-TRANSFER CCD IMAGE SENSOR

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Rochester, New York 14650

28 — IEDM 84 CH2099-0/84/0000-0028 $1.00 © 1984 IEDM

KODAK used LOCOS isolation which induced serious dark current and crystal defects degrading chip yield.

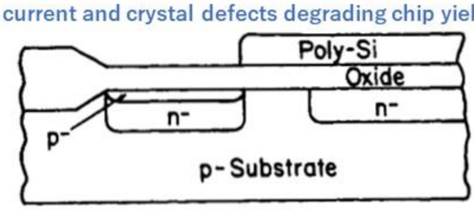

Fig. 1. Image cell schematic.

In this KODAK Pinned Photodiode IEDM1984 Paper, the Quantum Efficiency of 80% has been already achieved !

ABSTRACT

A pinned photodiode has been developed for use in an interline-transfer CCD. This photoelement has excellent blue response and high charge capacity. Both modeling and experimental results will be presented, including process considerations necessary to avoid unwanted barriers at the diode/transfer-gate edge.

CONCLUSION

Both the excellent blue response and high charge capacity of the pinned diode have been demonstrated. The processing of this device requires some care, however, to avoid the formation of potential barriers at the pinned diode/transfer-gate edge. This photoelement is ideal for applications requiring good blue response, large dynamic range, and no image lag. The processing considerations should also apply to the virtual-phase CCD.

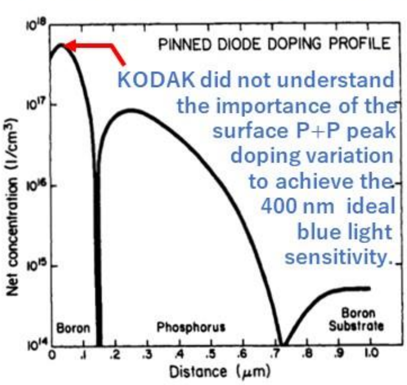

Fig. 2. Pinned diode doping profile.

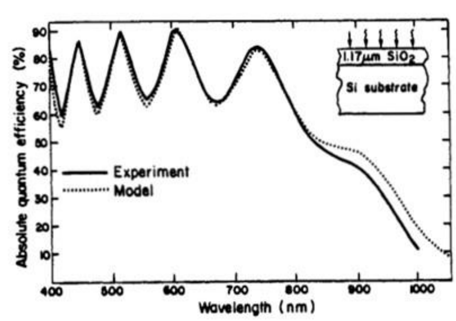

Fig. 4. Pinned diode spectral quantum efficiency. Solid and dotted curves are the experimental and theoretical curves, respectively.

Blue light has a very short Light Penetration Depth (LPD) of less than 0.05 μm.