

Semiconductor History Museum of Japan

**1975-85**

## **Improvement of photodiode for image sensor** **(Sony, Hitachi, NEC, Toshiba)**

~ Discrete Semiconductor/Others ~

In 1975, Sony proposed using a PNP transistor as the photodetector [3]. By providing a P<sup>+</sup> layer (emitter) for the light incident section, the sensor electrode that covers the entire light receiving surface of the photodiode can be eliminated to improve the light sensitivity greatly. It was a basic proposal for a pinned photodiode with a P<sup>+</sup> layer on the surface of the light receiving part.

Next, proposals were made separately by Hitachi and Sony to use the P<sup>+</sup> layer as the substrate potential. In 1977, Hitachi presented a structure in which the high-concentration surface P<sup>+</sup> layer is connected to a P-type substrate (well) and pinned it to the same potential as the substrate to increase the charge storage capacity and widen the dynamic range of the photodiode [4]. In 1978, Sony announced an FT (Frame Transfer) -CCD image sensor, using the photodiode with the same structure [5]. Sony succeeded for the first time in the world in prototyping a VTR-integrated color movie camera using a 2 / 3-inch 280,000-pixel FT-CCD image sensor that developed this technology, in 1981 [6].

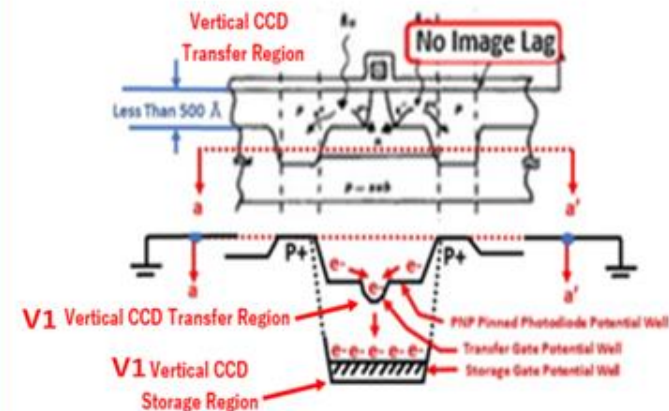
[3] Y. Hagiwara, Japanese Patent JP1975—134985

[4] N. Koike, I. Takemoto. Japanese Patent JP1977—837

[5] Y. Hagiwara, M. Abe, and C. Okada, "A 380H x 488V CCD imager with narrow channel transfer gates", Proc. The 10th Conference on Solid State Devices, Tokyo, (1978): Japanese Journal of Applied Physics, vol. 18, Supplements 18-1, pp. 335-340, (1979)

## Locos Free Process

SSDM1978 Paper



Sony 1980 Video Movie has in one body an 8 mm VTR and One Chip FT CCD Image Sensor with the PNP Double Junction type Pinned Photodiode developed by Hagiwara in 1978