

On June 9, 1975, Philips invented and filed a Netherland patent application of the PNP double junction type Buried Photodiode while Sony invented and filed a Japanese patent application of the NPN double junction type and the NPNP triple junction type Pinned Photodiodes on October 23, 1975. Sony also invented and filed a Japanese patent application of the PNP double junction type Pinned Photodiodes on November 10, 1975.

In the SSDM1978 conference in Tokyo, Sony reported for the first time in the world the PNP Double Junction type Photodiode with a high Quantum Efficiency (QM) of more than 50 %. Sony used the adjacent P+ heavily doped Channel-Stop region for pinning the surface hole accumulation region for the Pinned Photodiode in order to realize the complete charge transfer capability and the no image lag feature in order to achieve Electronic Shutter action mode as originally defined in Japanese Patent Applications JPA1975-127646, JPA1975-127647 and JPA1975-134985.

In the IEDM1984 conference, KODAK reported the same PNP photodiode with the QE of more than 60%. KODAK also realized the importance of pinning the surface of the PNP double junction type photodiode and used the LOCOS isolation for pinning the surface in order to realize the complete charge transfer and no image lag feature.

KODAK named this PNP junction type photodiode as "Pinned Photodiode" in the IEDM1984 conference. But KODAK did not invent Pinned Photodiode. Sony did.

Sony invented in 1975, developed and reported in the SSDM1977 conference at Tokyo in 1977 for the first time in the world, Pinned Photodiode, used in the form of an analog two-phase clocking-mode CCD analog delay line with the built-in directionality, which was created by the narrow-channel charge transfer gate effect in order to achieve the complete charge transfer action mode. and also in the form of a Frame Transfer CCD type area image sensor in the SSDM1978 conference in Tokyo.

On June 9, 1975, Philips invented and filed the patent application on the PNP junction type Buried Photodiode with the surface hole accumulation region connected with the high resistivity substrate with a large RC delay constant. It was not Pinned Photodiode.

On October 23, 1975, Sony invented and filed the patent application on the PNP junction type Buried Photodiode with the surface accumulation region pinned directly by the metal contact with the zero RC delay time constant in order to realize the high-frequency operation of the electronic shutter action mode.

NEC developed and reported at IEDM1982 the PNP junction type Buried Photodiode which was identical with the photodiode defined by Philips in 1975. Both NEC type and Philips type Buried Photodiodes have the serious non-zero RC delay time constant with the floating surface because both Philips and NEC photodiodes have the surface hole accumulation region being connected only to the high resistivity substrate without the grounded heavily-doped metallic surface channel stops region.

https://eds.ieee.org/images/files/newsletters/Newsletter_Jan23.pdf

[P2021_IJSSA2021_Paper_20210616_on_Electrostatic_and_Dynamic_Analysis_of_Pinned_Photodiodes.html](#)

[ICCCAS2023_Conference_paper_on_"AIPS_with_Pinned_Buried_Photodiode_used_for_Robot_Vision_and_Solar_Cell_Panel"](#)

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