

**UNITED STATES INTERNATIONAL TRADE COMMISSION
Washington, D.C. 20436**

**Before the Honorable Bryan F. Moore
Administrative Law Judge**

In the Matter of

**CERTAIN SENSORS WITH PIXELS AND
PRODUCTS CONTAINING THE SAME**

Investigation No. 337-TA-1403

**OPENING EXPERT REPORT OF DR. DEAN NEIKIRK
REGARDING U.S. PATENT NOS. 11,721,714; 9,064,764; 9,905,599; AND 10,224,359
(January 31, 2025)**

Volume I

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57. In 1993, Eric Fossum, from NASA's Jet Propulsion Laboratory, demonstrated a CMOS active pixel image sensor with intra-pixel charge transfer. This was further developed into an array of pixels that utilized pinned photodiodes and other circuitry. This led to commercialization of CMOS sensors that could achieve performance on par with, and later exceeding, CCD sensors. By the late 2010s CMOS sensors had largely if not completely replaced CCD sensors in the commercial market.

3.1.2 Pixel Fundamentals

58. At the heart of a CMOS image sensor lies an array of light-sensitive pixels, each of which has a photodiode capable of detecting light. A photodiode converts incoming photons into electrons and holes (i.e., charge carriers). The quantity of charge carriers collected at each pixel determines its brightness. Photodiodes are typically fabricated by doping a semiconductor layer to create a junction, which is used for sensing light. The photodiode junction is then connected to a metallization layer that carries the electrical signal to external circuits. By assembling this data across all pixels, the sensor constructs an image or video corresponding to the captured scene.

59. An ideal image sensor would convert every incoming photon into a collected electron or hole. However, in practice, some photons and some electrons are lost during conversion. Some incident photons may be lost because they are reflected before reaching the photodiode, while others may be lost because they pass through the semiconductor layer without being absorbed. Even when photons generate charge carriers, some of those may not be collected by circuitry. Quantum efficiency is the measure of how close to ideal a given image sensor performs. Quantum efficiency is generally defined as ratio of electrons collected per photons incident on an optoelectronic device.