

# A Unique Sub-micron Scanning System use for CMOS APS crosstalk characterization

Igor Shcherback, Boris Belotserkovsky, Orly Yadid-Pecht

The VLSI Systems Center  
Ben Gurion University  
P.O.B. 653 Beer-Sheva 84105, ISRAEL  
Tel: 972-8-6461512  
Fax: 972-8-6477620  
E-Mail: [oyp@ee.bgu.ac.il](mailto:oyp@ee.bgu.ac.il)

## ABSTRACT

This paper presents the pioneer use of our unique Sub-micron Scanning System (SSS) for point spread function (PSF) [1,2] and crosstalk (CTK) [3] measurements of focal plane CMOS Active Pixel Sensor (APS) arrays.

The system enables the combination of near-field optical and atomic force microscopy measurements with the standard electronic analysis. This SSS enables full PSF extraction for imagers via sub-micron spot light stimulation. This is unique to our system. Other systems provide Modulation Transfer Function (MTF) measurements, and cannot acquire the true PSF, therefore limiting the evaluation of the sensor and its performance grading. A full PSF is required for better knowledge of the sensor and its specific faults, and for research – to enable better optimization of pixel design and imager performance.

The system inputs an optical signal and outputs an electrical signal. The SSS is capable to hit onto a desirable well-defined point within the scanning area. It is able to focus the incoming light signal onto a spot of a desirable diameter size (e.g.,  $d < 0.5$  micron or  $d < 0.35$  micron according to the technology) after penetration through a certain transparent oxide depth without beam broadening, i.e., the desirable spot size is maintained during the scan.

Based on the thorough scanning of different “L” shaped pixel designs (the responsivity variation measurements on a subpixel scale) the full PSF was obtained and the CTK calculated; An optical spot of size 0.5um was used to scan the APS over a single pixel and its immediate and second neighbors in a raster fashion (see Fig. 2). The data acquisition was taken at a particular pixel within the 70x70 um scanned area, i.e., only one pixel (14x14um) was read out at each scan point. The obtained signal, i.e., the electrical outcome at each point as a function of the spot position provides a 2D signal map (see Fig. 3) of the pixel response, representing the full 3D charge distribution in the device. A number of chips were scanned and integrated over the pixel area in order to obtain the resultant output signal for each of the scanned pixels. The CTK is determined then as the ratio between the pixels output signals.

The results indicate that the PSF use for the CTK measurements enables not only its magnitude determination, but also track of its main causes. The pronounced asymmetry of the diffusion and CTK within the array [4,5,6], mostly caused by the certain pixel architecture and the pixels arrangement is explained by means of a semi-analytical model for photoresponse estimation of a photodiode based CMOS APS. The model covers the substrate diffusion effect together with the influence of the photodiode active area geometrical shape and size.

We show that for any potential pixel active area shape a reliable estimate of the CTK in the imager is possible; the PSF use for the CTK measurements enables not only its magnitude determination (that can be done by regular optical measurements [1,7]), but also to discover its main causes, enabling the design optimization per each potential pixel application.

## REFERENCES

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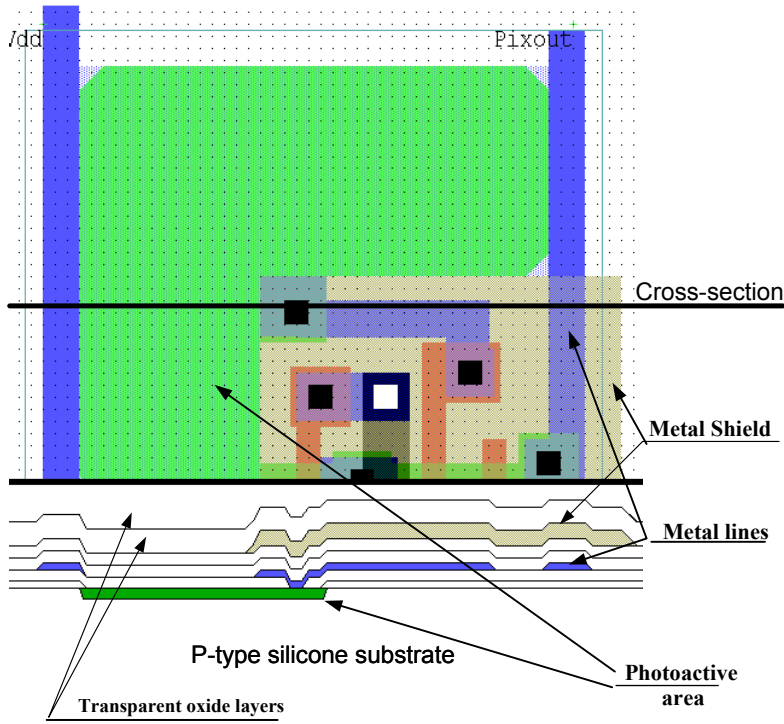


Fig. 1. Layout/cross-section example of an L-shaped active area pixel design.

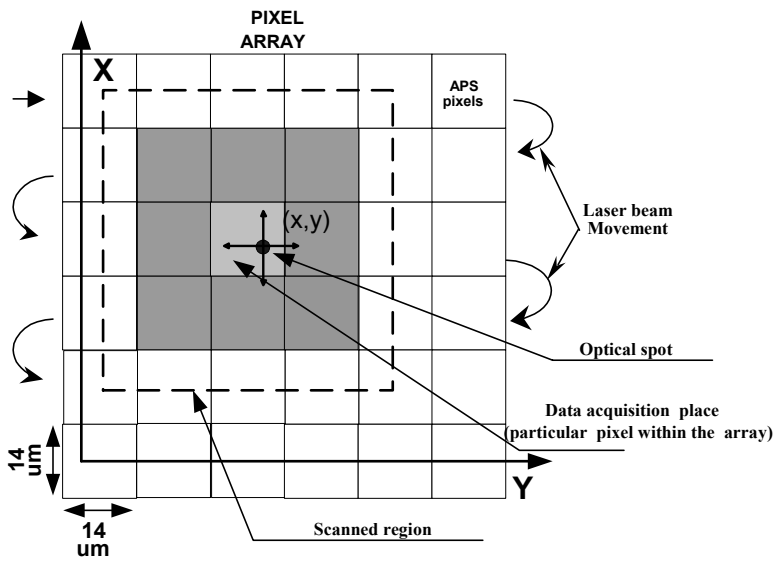


Fig.2. Experiment description. The solid squares represent the APS array. The optical spot (dark filled spot) is scanned over the array in a raster fashion within the scanned region (dashed line rectangle).

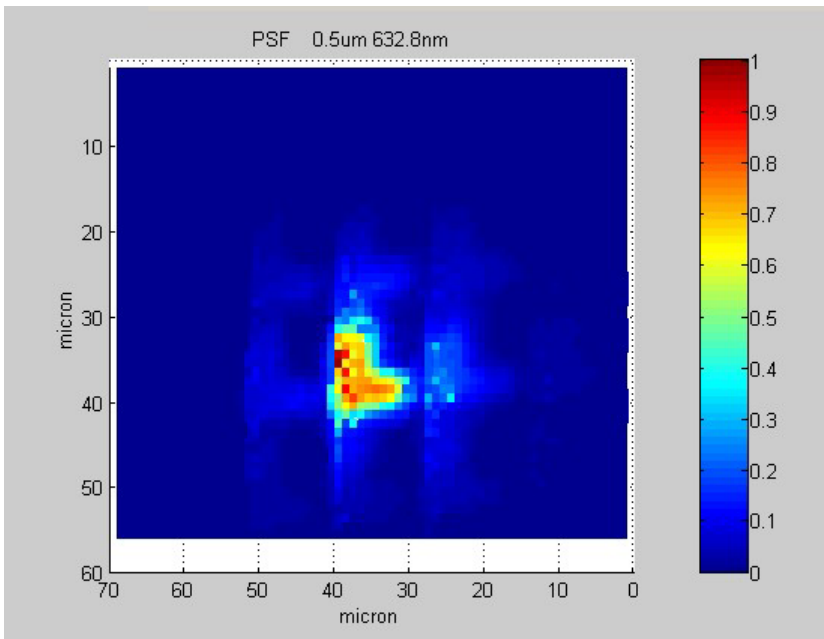


Fig. 3. Plot example of the actual measured PSF for the "L" shaped pixel