

TCAD Modeling of Devices for Quanta Image Sensors

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Abstract

The Quanta Image Sensor (QIS) is a possible 3rd generation image sensor. A QIS consists of a large array of photodetectors (perhaps a billion) that are capable of sensing a single photoelectron with high SNR. Such a binary output photodetector is called a "jot". It requires small size (e.g. 500 nm pitch), high quantum efficiency, and very low readout noise (e.g. <0.2 electrons rms). A key requirement for the jot is high conversion gain. A target goal is 1 millivolt per electron which is achieved by having very low sense node capacitance.

We have been investigating various jot device structures using the Synopsys TCAD package using a slightly modified 65 nm backside-illuminated (BSI) CMOS image sensor (CIS) process. In this paper we will describe a novel pump gate jot device with a JFET source-follower. A pump-gate jot with MOS source follower was presented recently [1,2]. The new JFET structure promises higher conversion gain and lower readout noise. The preliminary structure, operation and characteristics of the device using TCAD analysis will be presented.

[1] J.J. Ma, D. Hondongwa, and E.R. Fossum, *Jot Devices and the Quanta Image Sensor*, (invited) in Technical Digest of the 2014 IEEE International Electron Devices Meeting (IEDM), pp. 247-250, San Francisco, CA December 15-17, 2014.

[2] J.J. Ma and E.R. Fossum, *A Pump-Gate Jot Device with High Conversion Gain for Quanta Image Sensors*, IEEE J. Electron Devices Society, Vol. 3(2), pp. 73-77, March 2015.