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Characterization of Double Modified Internal Gate Pixel by 3D Simulation Study

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We have developed a novel photon detector concept based on Modified Internal Gate Field Effect Transistor (MIGFET) wherein a buried Modified Internal Gate (MIG) is implanted underneath the channel of a FET. In between the MIG and the channel of the FET there is depleted semiconductor material forming a potential barrier between charges in the channel and similar type signal charges located in the MIG. The signal charges in the MIG have a measurable effect on the conductance of the channel. In this paper a double MIGFET pixel is investigated comprising two MIGFETs. By transferring the signal charges between the two MIGs Non-Destructive Correlated Double Sampling is enabled.

Electrical parameters of the double MIGFET pixel have been evaluated by 3D TCAD simulation study. Simulation results show the absence of interface generated dark noise, significantly reduced interface generated 1/f noise due to deep buried channel operation, well performing NDCDS readout, and blooming protection due to an inherent vertical anti-blooming structure. In addition, the backside illuminated thick fully depleted pixel design results in low crosstalk due to lack of diffusion and good quantum efficiency from visible to Near Infra-Red (NIR) light. These facts result in excellent signal-to-noise ratio and very low crosstalk enabling thus excellent image quality. The simulation demonstrates the charge to current conversion gain for source current read-out to be 0.89 nA/e.

Key words: device simulation, Back-Side Illuminated, BSI, image sensor, imaging, modified internal gate, MIG, ultra low noise, low dark-current, low crosstalk, high quantum efficiency, vertical anti-blooming, fully depleted, non-destructive readout, non-destructive correlated double sampling.

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