**Session 32: Optoelectronics, Displays, and Imagers - CMOS Photodetectors**
Wednesday, December 5, 9:00 AM
Continental Ballroom 7-9
*Co-Chairs: S. Pellegrini, STMicroelectronics*
*P. Malinowski, imec*

9:05 AM - 9:30 AM
**32.1 Optocoupling in CMOS,** *V. Agarwal, S. Dutta, A. J. Annema, R. J. E. Hueting, J. Schmitz, M.-J. Lee*, E. Charbon* and B. Nauta, University of Twente, *EPFL*

This is the first experimental demonstration of data communication using a monolithically integrated optocoupler realized in a standard CMOS technology without any post-processing. The proposed optocoupler occupies very low area, can achieve data rate of a few Mbps and is very attractive for intra-chip communication and smart power applications.

9:30 AM - 9:55 AM
**32.2 High Voltage Generation Using Deep Trench Isolated Photodiodes in a Back Side Illuminated Process,** *F. Kaklin, J. M. Raynor*, R. K. Henderson, The University of Edinburgh, *STMicroelectronics Imaging Division*

We demonstrate passive high voltage generation using photodiodes biased in the photovoltaic region of operation. The photodiodes are integrated in a 90nm back side illuminated (BSI) deep trench isolation (DTI) capable imaging process technology. Four equal area, DTI separated arrays of photodiodes are implemented on a single die and connected using on-chip transmission gates (TG). The TGs control interconnects between the four arrays, connecting them in series or in parallel. A series configuration successfully generates an open-circuit voltage of 1.98V at 1klux. The full array generates 423nW/mm2 at 1klux of white LED illumination in series mode and 425nW/mm2 in parallel mode. Peak conversion efficiency is estimated at 16.1%, at 5.7klux white LED illumination.

9:55 AM - 10:20 AM
**32.3 Through-silicon-trench in back-side-illuminated CMOS image sensors for the improvement of gate oxide long term performance,** *A. Vici, F. Russo*, N. Lovisi*, L. Latessa*, A. Marchioni*, A. Casella*, F. Irrera, Sapienza University of Rome, *LFoundry, a SMIC Company*

To improve the gate oxide long term performance of MOSFETs in back side illuminated CMOS image sensors the wafer back is patterned with suitable through-silicon-trenches. We demonstrate that the reliability improvement is due to the annealing of the gate oxide border traps thanks to passivating chemical species carried by trenches.

10:20 AM - 10:45 AM
**32.4 High-Performance Germanium-on-Silicon Lock-in Pixels for Indirect Time-of-Flight Applications,** *N. Na, S.-L. Cheng, H.-D. Liu, M.-J. Yang, C.-Y. Chen, H.-W. Chen, Y.-T. Chou, C.-T. Lin, W.-H. Liu, C.-F. Liang, C.-L. Chen, S.-W. Chu, B.-J. Chen, Y.-F. Lyu, and S.-L. Chen, Artilux Inc.*

We investigate and demonstrate the first Ge-on-Si lock-in pixels for indirect time-of-flight measurements. Compared to conventional Si lock-in pixels, such novel Ge-on-Si lock-in pixels simultaneously maintain a high quantum efficiency and a high demodulation contrast at a higher operation frequency, which enable consistently superior depth accuracies for both indoor and outdoor scenarios. System performances are evaluated, and pixel quantum efficiencies are measured to be >85% and >46% at 940nm and 1550nm wavelengths, respectively, along with demodulation contrasts measured to be >0.81 at 300MHz. Our work may open up new routes to high-performance indirect time-of-flight sensors and imagers, as well as potential adoptions of eye-safe lasers (e.g. wavelengths > 1.4µm) for consumer electronics and photonics.

10:45 AM - 11:10 AM
**32.5 CMOS-Integrated Single-Photon-Counting X-Ray Detector using an Amorphous-Selenium Photoconductor with 11×11-$\mu m^2$ Pixels,** *A. Camlica, A. El-Falou, R. Mohammadi, P. M. Levine, and K. S. Karim, University of Waterloo*

We report, for the first time, results from a single-photon-counting X-ray detector monolithically integrated with an amorphous semiconductor. Our prototype detector combines amorphous selenium (a-Se), a well-known X-ray photoconductive material suitable for large-area applications, with a 0.18-µm-CMOS readout integrated circuit containing two 26×196 photon counting pixel arrays. The detector features 11×11-um2 pixels to overcome a-Se count-rate limitations by unipolar charge sensing of the faster charge carriers (holes) via a unique pixel geometry that leverages the small pixel effect for the first time in an amorphous semiconductor. Measured results from a mono-energetic radioactive source are presented and demonstrate the untapped potential of using amorphous semiconductors for high-spatial-resolution photon-counting X-ray imaging applications.