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Graphene-Enabled Silicon-Integrated Photodiode for DUV Imaging

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We present a novel scalable graphene-silicon hybrid photodiode that enables deep UV imaging. We have a created a photodiode with a reduced dead layer entrance window. Existing photodiodes are limited in sensitivity for low wavelengths due to the low penetration depth of photons of < 400 nm. Typical photodiodes have a junction implant which causes the low penetrating photons to be recombined in this dead layer. Here, we have utilized the near transparent nature of single layer graphene to create a junction with a minimum dead layer. To have a full active bulk volume we have combined a single junction ring (n++ bias ring) with single layer graphene. The graphene acts as a large field plate which overhangs the junction ring, on top of a thin dielectric, and covers the entire active area, 5x5 mm2. When a reverse bias is applied the detector depletes as one would expect the region underneath a field plate to deplete. Transient Current Technique (TCT) measurements have been performed to study the charge uniformity of the device and it has been shown that the charge collected is 100% across the entire area of the detector, however the collection time increases as you move further away from the junction ring this is due to the path length of the electrons along the surface of the device as shown in figure 2. Additional characterizations have been performed to evaluate the sensitivity of the device as a function of wavelength in comparison to a device with an ultra-shallow junction implant. The results show that the graphene-enhanced device shows far greater performance in the 200-400 nm wavelength range. It has been shown that this technology can be used to create a hybrid pixel detector for DUV imaging as shown in figure 3

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