Large Area Organic Photodetectors for Radiation Detection Applications

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Abstract:

There is a need for reduction in weight, power consumption, and cost of radiation detectors to enable new ways of deploying sensors for nonproliferation. These factors are key to applications such as sensors mounted on swarm robotics, large area portals at transportation checkpoints, and UAVs [1]. Legacy technology consists of PMT and scintillator rods [2]. The organic photodetector (OPD) offers a compelling replacement solution because of the low-cost, simple fabrication methods, freedom afforded through material selection and design, and device stability. While OPD performance has significantly improved, response times of 30 microseconds remain a limiting factor for the detection of light produced on scintillators for radiation source detection and identification [3].

The objective of our research is to develop photon-counting OPDs by reducing response time through selection of absorber materials and device architectures based on electronic noise and optoelectronic performance.

For our method, we perform data-driven modeling of devices based on rigorous characterization. We perform temperature-controlled measurements of the photodiode’s current-voltage characteristics over 10 orders of magnitude of irradiance. We use the Prince equivalent circuit model to extract parameters that enable computing metrics relevant to low-light conditions [4]. We have applied PEIE surface treatments [5] as well as thickness optimization of the absorber to improve charge extraction and reduce thermal noise [3].

We are currently investigating the incorporation of small-molecule absorbers and bi-layer absorbers comprised of interfaces of donor and acceptor molecules such as C60 and rubrene [6]. We are selecting materials and optimizing design through ellipsometry data and transfer-matrix methods of modeling optical absorption.

References:


