Abstract

Infrared photodetectors are essential to many applications including surveillance, communications, and biological imaging. The shortwave infrared spectral region (SWIR: 1-3 mm) is particularly powerful for health monitoring and medical diagnostics. However, current SWIR photodetection technologies are largely based on epitaxially grown inorganic semiconductors which are costly, require complex processing and impose cooling requirements incompatible with wearable electronics. Organic semiconductors are being developed for infrared detectors to enable low-cost direct deposition, conformal coverage, and facilitate monolithic integration and resolution not achievable by using current technologies.

Our recent efforts to advance the spectral response of organic photodetectors into the SWIR are introduced. Organic semiconductors responsive to SWIR are just emerging, and only a few organic materials have been reported that exhibit significant quantum efficiency in the spectrum past 1 mm. First, we discuss the main bottlenecks associated with fast recombination of excitons and carriers, which are more challenging to address in narrow bandgap photodetectors in comparison to devices operating in the visible to NIR. Second, we call attention to discrepancies in the literature regarding performance metrics. We share our perspective on potential pitfalls that may lead to over-estimated values, with particular attention to the detectivity (signal-to-noise ratio) and temporal characteristics, in order to ensure a fair comparison of device performance. Third, based on our understanding of loss mechanism, detectivity exceeding 1011 Jones, comparable to commercial germanium photodiodes, was achieved by using high dielectric additive. The high dielectric additive was shown to enhance both dissociation and charge transport, and be able to engineer the electronic properties of the photoactive layer. High performance organic SWIR photodetectors were incorporated into wearable physiological monitors and SWIR spectroscopic imagers that enable compositional analysis. Finally, our recent ongoing work on SWIR photodiodes based non-fullerene acceptors and suggestions for future work were briefly discussed.