

2026 HBCU CHIPS Network Conference

Contribution ID: 28

Type: ORAL

IR Photodetector based on the contactless-PdSe₂ integration with Few-Layered MoSe₂ Field-effect Transistor

Wednesday, April 1, 2026 1:50 PM (20 minutes)

Narrow-bandgap two-dimensional (2D) semiconductors are promising for near- and far-infrared photodetection, particularly at telecommunication wavelengths, but their performance is often limited by high dark current, carrier recombination, and thermal noise. Here, we report a hybrid van der Waals phototransistor that overcomes these challenges by integrating contact-free palladium diselenide (PdSe₂) as an infrared-absorbing layer with a molybdenum diselenide (MoSe₂) field-effect transistor (FET). Exfoliated PdSe₂ back-gated FETs exhibit ambipolar transport with hole and electron mobilities of 24.8 and 58.4 cm² V⁻¹ s⁻¹, respectively. Under 1650 nm illumination, PdSe₂ devices show clear photocurrent generation and a responsivity of ~300 mA W⁻¹ at a gate voltage of 15 V, confirming its suitability as a narrow-bandgap IR photodetector. To achieve tunable and enhanced photoresponse, few-layer PdSe₂ is transferred onto the channel of a MoSe₂ FET while remaining electrically isolated from the metal contacts. In this architecture, PdSe₂ acts as the primary IR absorber, whereas MoSe₂ provides efficient charge transport and gate control. The resulting spatial separation significantly improves device performance, yielding responsivities up to 972 mA W⁻¹ at a low power density of 1.5 mW mm⁻².

Academic or Professional Status

Graduate Student

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