All-In-One Infrared Imaging: Colloidal Quantum Dot Pixel Mosaics for Enhanced Multi-Band Infrared Photodetectors

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With applications ranging from astronomy and environmental monitoring to night vision and medical diagnostics, infrared (IR) imaging technologies are more in demand than ever. Despite the fact that single-element detectors with high performance have been demonstrated, multi-band imagers have been rarely reported. Traditional IR imagers are also fragmented and rely heavily on epitaxially grown semiconductors, which face inherent challenges, including high fabrication costs, low yield, and limited compatibility with complementary metal-oxide-semiconductor technology. Here, surface-passivated InAs/ZnSe core/shell colloidal quantum dots (CQDs) are introduced as a solution-processable platform offering tunable absorption across the IR spectrum, high carrier mobility, direct bandgaps, low exciton binding energies, and reduced thermal conductivity. Using lift-off microfabrication, CQD pixels were patterned with a critical feature size of 2 μm, achieving uniform arrays with high optical and electrical performance. A focal plane array imager with a resolution of 256 × 256 pixels was also fabricated using this platform and integrated with a silicon-based readout integrated circuit. This architecture enables broadband spectral response across the near-infrared and short-wave infrared ranges, from 0.9 to 1.5 μm, with responsivity values of 0.08 and 0.11 A W-1 and external quantum efficiencies of 24.5 and 15% at 0.96 and 1.43 μm, respectively. This approach offers a cost-effective, versatile solution that addresses the limitations of traditional IR imaging technologies, paving the way for next-generation imaging systems.

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