Advances in 2D Materials for Infrared Photodetection: Synthesis, Heterostructures, and Device Innovations

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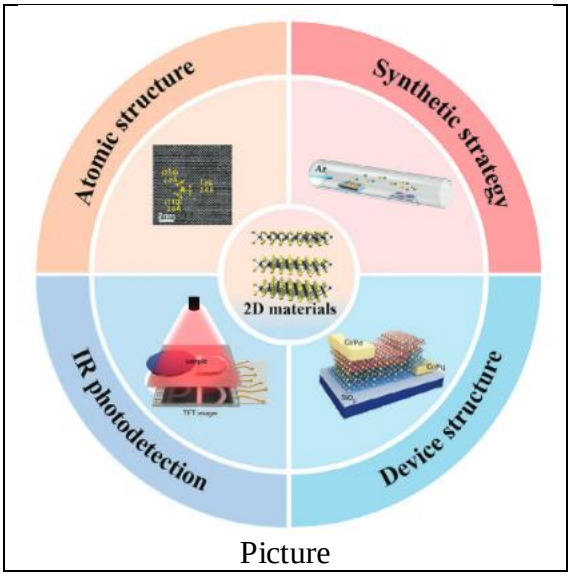
Two-dimensional (2D) materials have emerged as transformative candidates for infrared photodetection, boasting exceptional properties including high carrier mobility, tunable bandgaps, and strong light-matter interactions. Despite such great potential, critical challenges persist: achieving broadband spectral responses (for example, covering the ultraviolet to far-infrared range), minimizing dark currents (to below 10^{-10} A), and maximizing on/off ratios (to above 10^3). The report will explore recent advancements in three key areas to address these issues: synthesis techniques of 2D materials, their intrinsic material properties, and the design of innovative heterostructures. Key topics to be discussed include van der Waals heterostructures, photodetection mechanisms, and mixed-dimensional device architectures. Furthermore, we will highlight the current challenges in scalable fabrication of 2D material-based infrared photodetectors, and propose AI-driven material discovery as a promising pathway to accelerate their practical applications in commercial infrared detection.



Picture

Pic.1 The schematic diagram illustrates the four key aspects of 2D materials in infrared optoelectronic application.

Bibliography

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