光驱动的鳍式场效应晶体管

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现有光电二极管和场效应光电晶体管设计中，传统二维平面结构限制了光生载流子的传输效率和光电压调制能力，从而影响了器件性能。鉴于此，探索和设计新型的器件架构，以实现宽波段光响应并显著提高灵敏度，对于硅基红外探测技术的进步至关重要。

中国科学院重庆绿色智能技术研究院魏兴战研究员团队提出了一种光驱动的鳍式场效应晶体管（photo-FinFET）。该器件的设计灵感来自经典的微电子器件鳍式场效应晶体管（FinFET）。通过引入红外光敏的鳍型栅，使得光电压对沟道的调控从传统的二维平面扩展到了三维空间，进而实现了高灵敏和宽波段响应的硅基红外探测。

通过该结构的设计，不仅能够利用硫化铅-硅异质结来耗尽硅沟道，从而抑制暗电流，还能够通过界面光电压来有效调制沟道电导，从而产生显著的红外光响应。实验结果显示，在室温背景下，该器件实现了覆盖从可见光（635 nm）到短波红外（2700 nm）的宽波段光响应，以及快速的响应速度（150 μs）。此外，得益于低暗电流，该器件在 1550 nm 和 2700 nm 光照下，分别展现出了 3.2×10^{-12} W·Hz$^{-1/2}$ 和 2.3×10^{-11} W·Hz$^{-1/2}$ 的等效噪声功率。

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Photo-driven fin field-effect transistors

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In existing designs of photodiodes and field-effect phototransistors, the traditional two-dimensional planar structure limits the transport efficiency of photocarrier and the modulation ability of photovoltage. Therefore, the exploration and design of novel device architectures are crucial for advancing silicon-based infrared detection technology.

The research group of Prof. Xingzhan Wei from the Chongqing Institute of Green and Intelligent Technology, Chinese Academy of Sciences, proposed a photo-driven fin field-effect transistor (photo-FinFET). The design of photo-FinFET takes inspiration from the classical microelectronic device design, the FinFET, which extends photovoltage control from a two-dimensional plane to a three-dimensional space, thereby realizing silicon-based infrared detection with high sensitivity and broadband photoresponse. The structural design of photo-FinFET offers two advantages: (i) it leverages the PbS-Si heterojunction to deplete the channel, suppressing the dark current. (ii) The photovoltage generated at the PbS-Si interface can efficiently modulate the channel, resulting in a substantial infrared photoresponse.

The design of the infrared fin gate enables the photo-FinFET to not only overcome the intrinsic light absorption limitation of silicon, but also exhibit low dark current and broadband infrared photoresponse at room temperature. Moreover, the fabrication process of the prototype device is compatible with silicon-based CMOS technologies, providing promising methods for the development of low-cost, low-power, and high-sensitivity silicon-based infrared detectors.

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