Ultrafast and broadband perovskite photodetectors for large-dynamic-range imaging

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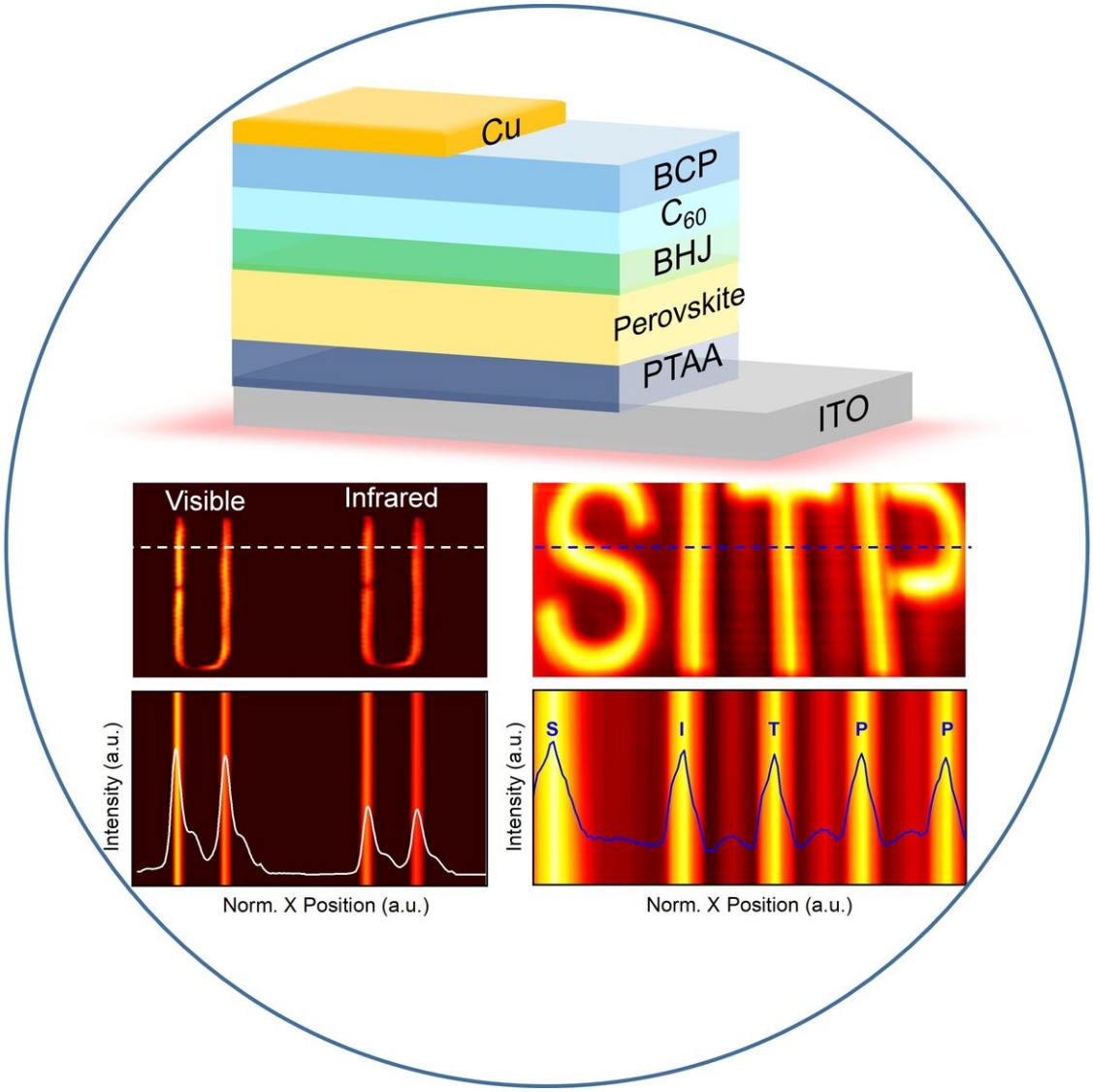

OIHP photodetectors for Visible and NIR (with an 830-nm long-pass filter) imaging, as well as imaging of SITP (an abbreviation of Shanghai Institute of Technology and Physics) letter graphics under LED illumination. The white and blue lines in the figure represent the normalized photocurrent signal intensity. Credit: by Chenglong Li, Hailu Wang, Fang Wang, Tengfei Li, Mengjian Xu, Hao Wang, Zhen Wang, Xiaowei Zhan, Weida Hu, Liang Shen

A solution-processed broadband photodetector based on organic-inorganic hybrid perovskite and organic bulk heterojunction has been demonstrated, achieving broadband response spectra up to 1000 nm with a high EQE in the NIR region, an ultrafast response speed of 5.6 ns and a wide linear dynamic range of 191 dB. Encouragingly, due to the high-dynamic-range imaging capacity, high-quality visible-NIR actual imaging is obtained, enabling the accelerated translation of solution-processed photodetector applications from the laboratory to the imaging market

Photodetectors, a key optoelectrical component for the translation of optical signals into electrical signals, are of great interest in a wide range of areas: industrial production, military affairs, biochemical detection, optical communication, etc. Organic-inorganic hybrid perovskites (OIHPs), owing to their excellent optical and electrical properties including tunable direct bandgap, preeminent optical absorption, high carrier mobility, and low trap density, have attracted immense research interest for thin-film solar cells, LEDs, and photodetectors. In recent years, the fabrication and characterizations of OIHPs have been advanced and photodetectors with high sensitivity, fast response, and large linear dynamic range have been reported. However, to circumvent existing limitations to the detection band of visible light resulting from the bandgap of the perovskite material, new device architectures and material systems are needed which offer high performance over a wide

spectral range up to NIR.

In the new paper published in *Light Science & Applications*, scientists from the State Key Laboratory of Integrated Optoelectronics, College of Electronic Science and Engineering, Jilin University, China, State Key Laboratory of Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy of Sciences and University of Chinese Academy of Sciences, China, and co-workers have designed new OIHP photodetectors combined with organic bulk heterojunction (BHJ) ofsuitable band structure, achieving a high external quantum efficiency (EQE) of higher than ~54% in the NIR region. Benefitting from low trap density in the light absorption layer and high carrier mobility in the transport layer, the OIHP/BHJ photodetectors have ultra-fast response times of just 5.6 nanoseconds by the transient photocurrent method (TPC) that can mitigate the issue of the resistance-capacitance time constant.

To further verify the broadband detection capability and large linear dynamic range (LDR), they adopted the OIHP/BHJ photodetectors to construct a single-pixel scanning optical imaging system. High-quality imaging of complex letter graphics and visible/NIR imaging of the heat coil are obtained through the imaging system based on the OIHP/BHJ photodetectors with large LDR, ultra-fast response speed, and room temperature stability. Hence, state-of-the-art OIHP photodetectors can accelerate the translation of solution-processed photodetector applications from the laboratory to the imaging market.

More information: Chenglong Li et al, Ultrafast and broadband photodetectors based on a perovskite/organic bulk heterojunction for large-dynamic-range imaging, *Light: Science & Applications* (2020). DOI: 10.1038/s41377-020-0264-5

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