Exciton-scissoring perfluoroarenes trigger photomultiplication in full color organic image sensors

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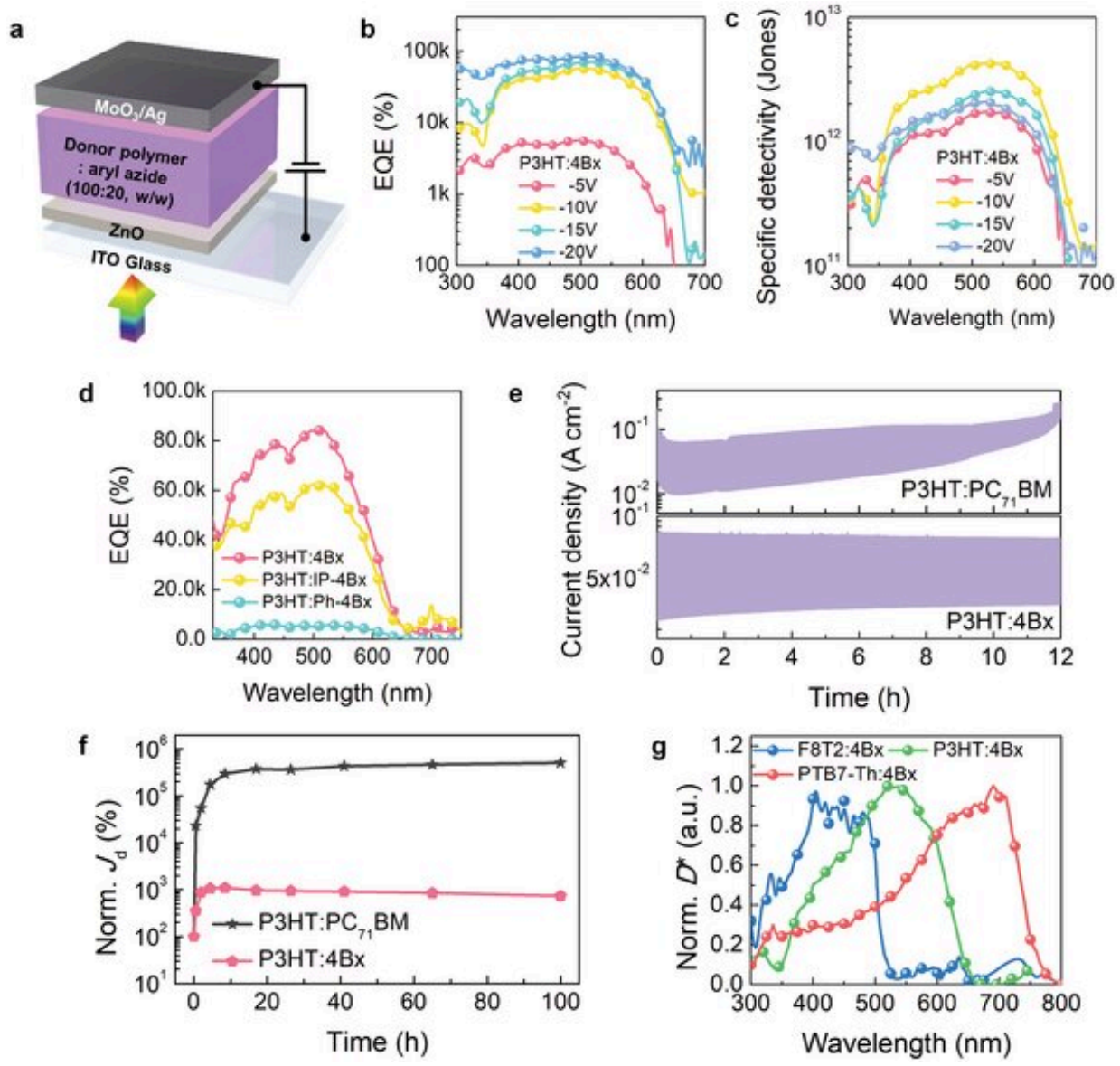

a) Schematic of the suggested PM-OPD structure. b,c) EQE and specific detectivity spectra of the aryl azide-based PM-OPD under various reverse biases, respectively. d) EQE spectra of the series of aryl azide-based PM-OPDs under a reverse bias of 20 V. e) Operational stability of PM-OPDs with P3HT:PC71BM (100:1, w/w) (upper) and P3HT:4Bx (100:20, w/w) (lower). f) Thermal stability of the PC71BM-based and 4Bx-based PM-OPDs at 85 °C. g) Normalized D* spectra of F8T2:4Bx-, P3HT:4Bx-, and PTB7-Th:4Bx-based PM-OPDs. Credit: *Advanced Materials* (2023). DOI: 10.1002/adma.202302786

In a recent study, a joint research team from POSTECH, UNIST, and Hanyang University has discovered a new functionality of perfluoroarenes that enables exciton scissoring in photomultiplication-type organic photodiodes (PM-OPDs) without the use of conventional acceptor molecules. The research findings have been published in *Advanced Materials*.

Organic photodiodes play a crucial role in various fields, including biometric technology, cameras, and optical communication. The development of a photo-amplifying organic photodiode has been hindered by the reactivity and sensitivity of electron receptors to the external environment, slowing down the commercialization process.

The research team, led by Professionals Dae Sung Chung and Dr. Juhee Kim from POSTECH, Professor BongSoo Kim and Myongjae Lee from UNIST, and Professor Do Wan Kim and Hyukmin Kweon from Hanyang University, overcame this challenge by implementing a novel approach using perfluoroarene photo-crosslinkers that provide electrochemical stability to the device.

The key to the success of the perfluoroarene-driven PM-OPDs lies in the interfacial band bending between the perfluoroaryl group and the

polymer donor. This phenomenon enables the rapid separation of excitons into electrons and holes, amplifying the formation of both holes in the device through electron trapping. As a result, high external quantum efficiency and B-/G-/R-selective PM-OPDs were demonstrated.

One of the significant advantages of the suggested PM-OPDs is their superior operational and thermal stabilities, thanks to the acceptor-free and covalently interconnected photoactive layer. Additionally, the research team successfully demonstrated finely patterned B-/G-/R-selective PM-OPD arrays, opening up new possibilities for highly sensitive passive matrix-type organic image sensors.

"This study represents a significant breakthrough in the field of organic photodiodes, as we have achieved both stability and color selectivity," said Professor Dae Sung Chung. "We believe that this breakthrough will greatly contribute to the future commercialization of organic image sensors."

More information: Juhee Kim et al, Exciton-Scissoring Perfluoroarenes Trigger Photomultiplication in Full Color Organic Image Sensors, *Advanced Materials* (2023). DOI: 10.1002/adma.202302786

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