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Near-Infrared Photodetector Consisting of J-Aggregating Cyanine Dye and Metal Oxide Thin Films TIMOTHY OSEDACH, Harvard University, ANTONIO IACCHETTI, Politecnico di Milano, RICHARD LUNT, Michigan State University, TRISHA ANDREW, PATRICK BROWN, GLEB AKSELROD, VLADIMIR BULOVIC, MIT — We demonstrate a photodetector structure that employs metal-oxide charge transport layers and that is sensitized at near-infrared wavelengths by a thin film of a J-aggregating cyanine dye. The high absorption coefficient of the J-aggregate film, combined with the use of a reflective anode and optical spacer layer, enables an external quantum efficiency (EQE) of 16.1 $\pm$ 0.1% (λ = 756 nm) to be achieved at zero-bias in a device consisting of an 8.1 $\pm$ 0.3 nm-thick dye film. The specific detectivity (D*) and response speed (f_{3dB}) of the fully-optimized device are measured to be $(4.3 \pm 0.1)\times10^{11}$ cm $Hz^{1/2}$ $W^{-1}$and 91.5 kHz, respectively. Modeling of our structure reveals that the photocurrent is limited by the diffusion of photo-generated excitons to the metal oxide/J-aggregate hetero-interface and we determine the exciton diffusion length in the J-aggregate film to be L_D = 2.0 $\pm$ 0.4 nm. This work provides insights relevant to the use of J-aggregating cyanine dyes in photodetector and photovoltaic applications and highlights the importance of engineering the optical field profile within such structures in order to maximize performance.

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