Top-Illuminated Mid-IR HgTe Colloidal Quantum Dot Photodiodes

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Colloidal quantum dots offer an inexpensive, solution-processed alternative to conventional, crystalline material devices for mid-infrared photodetection. pn-junction devices using HgTe quantum dots previously reached the background limit at cryogenic temperatures. These devices have since shown increased effective operating temperatures. [1] [2] For use in thermal imaging arrays, devices must be developed which are illuminated from the top.

The focus of this work is to understand and improve the performance of top-illuminated HgTe quantum dot photodiodes. Signal collection is a function of series resistance, diffusion length, and thin film absorption, and all can be improved separately for higher operating temperatures. We show results with a bottom n-type reflector contact, varying thicknesses of HgTe films of different mobility and doping profile and a semi-transparent metallic top electrode, made in a process compatible with integration into silicon readout chips. We also show an analysis of the temperature and photon flux dependence of the diode current, to gain insight into the dominant recombination mechanisms present in the device and the nature of the shunt resistance.

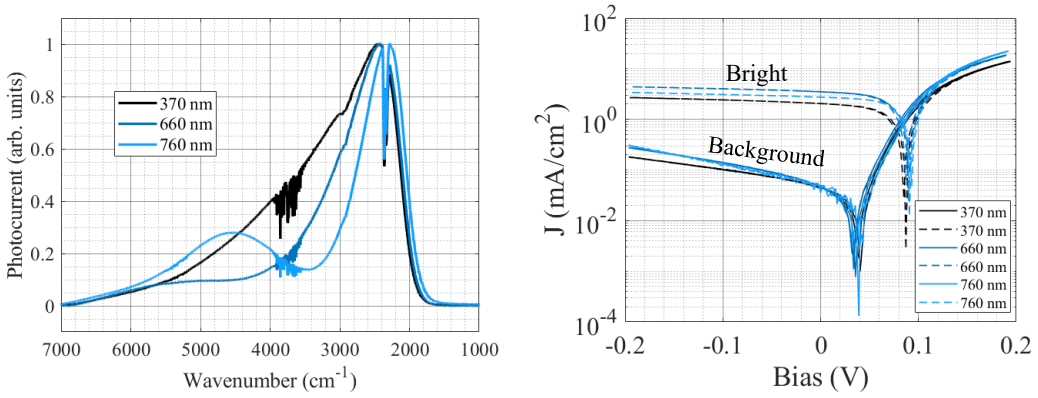

Figure 1: Photocurrent spectra of top-illuminated devices of varying thickness (left) and JV curves (right).

[1] J. C. Peterson, P. Guyot-Sionnest, Room-Temperature 15% Efficient Mid-Infrared HgTe Colloidal Quantum Dot Photodiodes. ACS Applied Materials & Interfaces. Article ASAP, (2023).

[2] X. Xue, M. Chen., Y. Luo, T. Qin, X. Tang, Light: Science and Applications **12**, 2(2023).

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