Synthesis of HgTe Colloidal Quantum Dots and Processing of Films to Maximize Photodetector Performance.

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Since 2011, HgTe colloidal quantum dots have been researched for infrared photodetection in the MWIR,[1] but also in the SWIR and LWIR. They are readily tunable in the MWIR by controlling the size around 12 nm as shown in Fig. (a). The detector performances are still below those of single crystal and epitaxial materials, but the solution processing promises high throughput and low-cost fabrication of simple detectors and imagers. Our goal is to raise the performance of 4.5 microns HgTe quantum dot at 300K to match polycrystalline PbSe ($D^*=10^{10}$Jones), for fair and fast thermal imaging at room temperature, and another related goal is to raise the BLIP temperature to thermolelectric temperatures.

This presentation focuses on the measurements of optical absorption, carrier mobility, and carrier lifetime of MWIR HgTe colloidal quantum dots, and how these properties inform the best possible performance achievable. Simple experimental methods based on photoconductors, as shown in Fig. (b), allow to obtain these properties.[2] Then we distinguish film preparations that use non-polar inks or polar inks of quantum dots. While both can give similar carrier mobility after mild annealing, the carrier lifetime is retained in one instance, while the carrier lifetime is shortened by trapping in the other. Such a study indicates clearly which is the better process, and leads to improved device performances as shown in Fig (c).

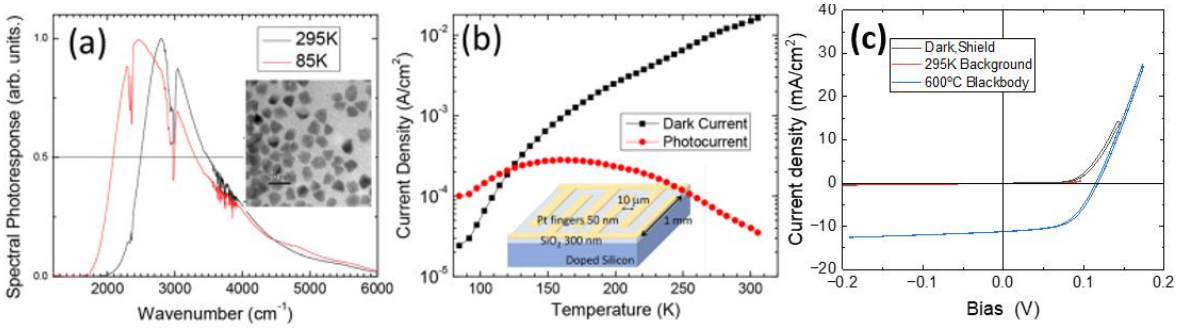

Figure . (a) Photoresponse spectra of a photoconductor of MWIR HgTe quantum dots. The inset is a TEM picture of the quantum dots. (b) Dark current and photocurrent temperature dependence. (c) JV curves of a MWIR PV device with 50% EQE and 10^{12} Jones at 85K without bias.

[1] S Keuleyan, E Lhuillier, V Brajuskovic, P Guyot-Sionnest, Mid-infrared HgTe colloidal quantum dot photodetectors, Nature Photonics 5 (8), 489-493 (2011)
[2] P Guyot-Sionnest, JC Peterson, C Melnychuk, Extracting Bulk-like Semiconductor Parameters from the Characterization of Colloidal Quantum Dot Film Photoconductors, The Journal of Physical Chemistry C 126 (40), 17196-17203 (2022)

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