Infrared Colloidal Quantum Dots for Detectors and Emitters

Philippe Guyot-Sionnest, Sean Keuleyan, Heng Liu and Emmanuel Lhuillier
James Franck Institute, The University of Chicago, 929 E. 57th Street, Chicago, IL 60637

BIOGRAPHY

TECHNICAL ABSTRACT
We explore colloidal quantum dots for mid-infrared detectors and emitters. The key property of colloidal quantum dots is the ease with which the optical absorption is controlled. To make colloidal quantum dots responsive in the mid-infrared, we use HgTe. In the bulk, HgTe is a semimetal with no useful photoresponse. With HgTe nanocrystals, a gap opens between the lowest energy electron state and the highest energy hole state, and the gap increases as the quantum dot gets smaller. This gap corresponds to the longest wavelength of absorption or emission of the nanocrystal. HgTe nanocrystals can be synthesized with good size control so that they have a well defined absorption edge. The colloidal solutions ink is then dried as thin films on planar electrodes. By controlling the nanocrystal sizes in the inks from 6 to 12 nm, photoresponse with cut-offs from 2 to 7 microns is obtained, as shown in the Figure. The response time of the detector is much faster than a millisecond and therefore fast enough for imaging applications. The nanocrystal inks are also well suited for multicolor pixelated printing on an underlying Si thin film transistor matrix. At present, the detectivity of the material is lower than the bulk single crystalline MCT by a couple orders of magnitude, but we have literally just started scratching the surface, in that most of the material is surface and accessible to chemical modifications.

Keywords: quantum dots, colloidal, HgTe, infrared, detector.