Abstract of

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Metal sulphide nanostructures were prepared by solid state reaction technique and electric and dielectric properties were explored using AC measurements. This was followed by their integration with silicon nanowires (Si NWs) to fabricate photodetectors with better characteristics. The prepared nanostructures were bismuth sulphide (Bi_2S_3) nanorods (diameter ~20 nm; length ~100 nm - ~150 nm), cadmium sulphide (CdS) nanoparticles (diameter ~17 nm), molybdenum disulphide (MoS_2) nanoflakes and zinc sulphide (ZnS) nanoparticles (diameter ~ 30 nm). The formation of these nanostructures was confirmed by x-ray diffraction (XRD) technique. ZnS nanoparticles and Si NWs were used to form hybrid devices for photodetection. Impedance plane plots of pressed pellets of Bi_2S_3 nanorods obtained in the frequency range 20 Hz to 2 MHz showed the presence of grains and grain boundaries from 310 K to 400 K. Small polaron hopping was observed as the charge transport mechanism in the nanorods. In CdS nanoparticles, Impedance plane plots from 300 K to 400 K in the same frequency range indicated the phases of grain boundaries, sub-grain boundaries and grains. Overlapped large polaron tunneling (OLPT) mechanism was observed in CdS nanoparticles. The large values of dielectric constants observed in CdS nanoparticles obey Maxwell-Wagner theory of interfacial polarization. Impedance spectroscopy of pressed pellet of MoS_2 nanoflakes indicated the presence of two dielectric relaxation processes associated with bulk and interfaces from 180 K – 280 K. Mott's 2D variable range hopping (VRH) model explains the conductivity of MoS_2 nanoflakes. We observed persistent photoconductivity, enhanced detectivity, responsivity, and external quantum efficiency (EQE) in hybrid ZnS nanoparticles (NPs) and vertical Si NW devices. ZnS nanoparticles (diameter ~30 nm) were prepared by co-precipitation method. Si NWs (length ~30 □m, diameter ~30-400 nm) were prepared by electroless chemical etching. Hybrid device showed ~10, 3 and 10 times enhancement of EQE, detectivity, and responsivity, respectively as compared with the Si NWs only devices. The enhancement is attributed to presence of low refractive index ZnS around Si NWs causing funneling of photon energy into Si NWs.