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Abstract

We have investigated AC & DC carrier transport and photodetection properties of Silicon nanowires (SiNWs), SiNWs/Polyacrylic acid (PAA), SiNWs/Titanium dioxide nanoparticles (TiO_2 NPs) and SiNWs/PAA/TiO_2 NPs hybrid devices. DC transport measurements were carried out using temperature dependent Current - Voltage (*IV)* characteristics from 290 K -77 K. AC measurements were performed using impedance spectroscopy from 20 Hz to 2 MHz at room temperature. The He-Ne laser having wavelength 632.8 nm was used for photodetection measurements. SiNWs and TiO_2 NPs were prepared by Metal Assisted Electro-less Chemical Etching (MACE) and co-precipitation method respectively. Length and diameter of SiNWs were ~ 40 µm and ~ 50 nm – 300 nm respectively. The diameter of TiO_2 NPs was ~ 50 nm. The surfaces of SiNWs were passivated with PAA, TiO_2 NPs and PAA/TiO_2 NPs by spinning and heating steps. We observed that incorporation of PAA, TiO_2 NPs and PAA/TiO_2 NPs on *p*-SiNWs enhanced electrical current than that of *n*-SiNWs and SiNWs only device. The incorporation of PAA into *p*-SiNWs resulted in ~ 10^6, 10^3, 10^2 times increase in electrical current, AC conductivity and dielectric constant respectively than that of *p*-SiNWs only device. We have also observed ~9, 4 and 9 times enhancement in responsivity, detectivity and external quantum efficiency in *p*-SiNWs/PAA hybrid device in comparison to *p*-SiNWs only device. In *p*-SiNWs/TiO_2 NPs hybrid device, we observed ~12, 5, 12, 100, and 70 times enhancement of external quantum efficiency, detectivity, responsivity, AC conductivity, and overall dielectric constant respectively. Ohmic like conduction was dominant followed by space charge limited current conduction (SCLC) with and without traps in *n*-SiNWs & *p*-SiNWs, *n*-SiNWs/PAA, *n* SiNWs/TiO_2 NPs & *p*-SiNWs/TiO_2 NPs, *n*-SiNWs/PAA/TiO_2 NPs & *p*-SiNWs/PAA/TiO_2 NPs devices. The *p*-SiNWs/PAA hybrid device followed Schottky thermionic emission model. The enhancement in electrical, dielectric and photodetection properties were attributed to the increment of acceptor like states at SiNWs interface. The presence of low refractive index material (PAA, TiO_2 NPs) around SiNWs caused funneling of photon energy into SiNWs, and improved photodetection properties.