Figure 1.1:	(a) Bohr model of the single atom with exciting and relaxing electron and (b) Change in energy bands of the atoms by varying the interatomic spacing.	4
Figure 1.2:	(a) Binary QDs, (b) Core-Shell QDs, (c) Alloyed QDs, and (d) Doped QDs.	9
Figure 1.3:	(a) Stranski-Krastanow growth mechanism of QDs, (b) Nanoscale patterning method for preparation of QDs, and (c) Schematic of La Mer's model with the experimental setup for preparation of colloidal QDs.	12
Figure 1.4:	(a) Energy as a function of configuration co-ordinate for the initial and final state of the electron transfer (Klimov, 2010), (b) Electron transfer rate for the different values of free energy against the size of the ZnO QDs.	15
Figure 1.5:	Schematic illustration of the changes of the density of states (DOS) with changes in the semiconductor structure from bulk to QDs.	17
Figure 1.6:	Schematic diagram of Transmission Electron Microscopy (TEM) (By Gringer (talk) - Commons: Scheme TEM, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=56 24170).	19
Figure 1.7:	Experimental measurement setup for spectrophotometry.	21
Figure 1.8:	(a) Interaction of incident light wave with the thin-film material at the incoming and outgoing interface, (b) Variation in the oscillations of the light wave due to the thickness of the thin- film, and (c) Photoluminescence due to excitation and recombination of an electron-hole pair.	21
Figure 1.9:	Experimental measurement setup for photoluminescence spectrometry.	22
Figure 1.10:	Experimental measurement setup for electrical characterization.	23
Figure 1.11:	(a) Experimental measurement setup for time response measurement, (b) Single LED (UV and White) source for device excitation, (c) Complete time response measurement setup with data acquisition using LabView.	24

Figure 1.12:Experimental measurement setup for photocurrent25measurement (automated data acquisition is achieved using

LabView).

- Figure 1.13:Implementation of spectrum selective photodetectors using31filter layer and cross-talk between the detectors.
- Figure 2.1:Complete device schematic with Ag (\sim 50 nm)/MoOx (\sim 8 40 nm)/CdSe QDs (\sim 80 nm)/ZnO QDs (\sim 40 nm)/ITO
- Figure 2.2: Flowchart of ZnO QD synthesis under the inert environment. 41
- Figure 2.3: Flowchart of CdSe QD synthesis under the inert environment. 42
- **Figure 2.4:** (a) TEM image of as-grown ZnO QDs with particle size 44 histogram and (b) TEM image of as-grown CdSe QD with particle size histogram.
- Figure 2.5:Selected area electron diffraction pattern of (a) as-grown ZnO45QD and (b) as-grown CdSe QD.
- **Figure 2.6:** Current density versus voltage curve for Devices A, B, and C 46 under dark condition and illumination of white LED (96.8 μ W/cm² at 500 nm).
- Figure 2.7: ZnO QDs HRSEM at a scale of 100 nm and particle size 47 histogram for annealing temperatures at (1) 250°C, (2) 350°C, and (3) 450°C.
- Figure 2.8:Band energy diagram of ZnO QDs against the particle size of
ZnO QDs; increase in the particle size leads the discrete bands
of ZnO QDs to continuum state.49
- **Figure 2.9:** Optical study of ZnO QD film annealed at 250, 350, and 450°C **50** for (a) αhv^2 versus hv for bandgap calculation and (b) absorption curve of ZnO QD film.
- Figure 2.10:Band alignment diagram of Ag/MoOx /CdSe QDs/ZnO QDs (a)51for the different annealing temperatures (250, 350, and 450 °C)of ZnO QDs and (b) barrier between the two CdSe QDs andZnO QDs; the barrier is dependent upon the size of the QDs.
- Figure 2.11: (a) Transient response of devices A, B, and C under 53 illumination of white LED for 1 s at an applied bias of 0V. (b) Enlarged rise time characteristics of devices A, B, and C under zero bias. (c) Enlarged fall time responses of devices A, B, and C under zero bias.
- **Figure 2.12:** Devices A, B, and C are compared for (a) photocurrent with **55** incident power density and (b) responsivity.
- **Figure 2.13:** Devices A, B, and C are compared for (a) detectivity and (b) **56** external quantum efficiency (EQE).

60

Figure 2.14:Schematic cross-sectional view of fabricated ZnO QDs based58TFT (a) ZnO QDs based TFT with sandwiched TiO2 layer
between Al2O3 layers and (b) ZnO QDs based TFT without
TiO2 layer.58

Figure 2.15:Drain current versus Drain voltage (a) for ZnO QDs based TFT59without embedding floating gate of TiO2 and (b) for ZnO QDs
based TFT with embedding TiO2 layer between the Al2O3
layers.

- **Figure 2.16:** Photoluminescence of TiO₂ film.
- **Figure 3.1:** Procedure for preparation of MoO_x solution for solution **66** processing deposition.
- Figure 3.2:Complete schematic device structure of the solution-processed68and thermally grown MoOx.
- **Figure 3.3:** HRSEM image of (a) solution-processed MoO_x-based device **69** before annealing at 280°C, (b) solution-processed MoO_x-based device after annealing at 280°C, (c) thermally grown MoO_x based device before annealing at 280°C, and (d) thermally grown MoO_x-based device after annealing at 280°C.
- Figure 3.4:(a) Photoluminescence (PL) excitation and emission spectrum70of colloidal ZnO QDs solution and (b) PL excitation and
emission spectrum of MoOx-solution.70
- Figure 3.5: Logarithmic current–voltage curve under light and dark 71 condition for (a) solution-processed MoO_x-based diode without annealing and (b) solution-processed MoO_x-based diode after annealing.
- **Figure 3.6:** Logarithmic current–voltage curve under light and dark **72** condition for (a) thermally grown MoO_x-based diode without annealing and (b) thermally grown MoO_x-based diode with annealing.
- **Figure 3.7:** A^2/C^2 versus voltage curve for (a) solution-processed MoO_x- **74** based diode and (b) thermally processed MoO_x-based diode.
- Figure 4.1:(a) Complete device schematic Au (~80 nm)/CdSe QDs (~3080nm)/ZnO QDs (~40 nm)/n-Si and (b) Fabricated and packaged
device under consideration.80
- **Figure 4.2:** (a) Photoluminescence and absorption spectrum of colloidal **82** CdSe QDs solution (b) Photoluminescence Excitation (PLE) spectrum of CdSe QDs for emission wavelength of 610 nm (2.03eV).

Figure 4.3:	CdSe QD energy band levels with the depiction of absorption and photoluminescence between the energy states.	85
Figure 4.4:	Reflectance and Transmittance normalized curve for gold thin film of thickness \sim 80 nm.	85
Figure 4.5:	(a) A^2/C^2 vs. voltage characteristics for calculation of barrier height and carrier concentration with the inset of C-V curve, (b) Width of depletion region (W) vs. voltage for the different values of dielectric constant (bulk (Hui, 2000), prepared QDs, and small QDs (Hui, 2000)).	86
Figure 4.6:	(a) J-V characteristics of the Pd/CdSe QDs Schottky diode with ZnO QDs as an ETL and without ZnO QDs layer in inset, (b) Time response characteristics of the Schottky diode for the light pulse of 1 sec without any applied bias.	89
Figure 4.7:	Charge distribution and energy band of Au/CdSe QD with ZnO QDs as an ETL.	91
Figure 4.8:	Photoresponse characteristics of self-powered Au/CdSe QDs based Schottky photodiode (a) Photocurrent density of device and optical power density plot of source against wavelength, (b) responsivity and detectivity of device against wavelength.	92
Figure 5.1:	(a) Schematic device structure and (b) fabricated ITO/PQT- 12/CdSe QDs/Au hybrid photodetector	100
Figure 5.2:	Schematic energy band diagram at thermal equilibrium.	101
Figure 5.3:	(a) Current density- voltage relationship of PQT-12/CdSe QD based hybrid self-powered photodetector under dark and light, inset shows the log plot, (b) Capacitance of the self-powered hybrid photodetector under the dark and illumination condition (96 μ W/cm ² at 500 nm).	103
Figure 5.4:	Time response characteristics under the pulsating LED light (96 μ W/cm ² at 500 nm) for an ON-OFF period of 1 sec.	104
Figure 5.5:	Schematic of the band energy diagram of CdSe QDs with PQT- 12 and Au electrode (a) under thermal equilibrium or dark condition (b) under the illumination of light.	105
Figure 5.6:	(a) Responsivity and detectivity of the hybrid self-powered photodetector at 0 V and (b) absorption and transmittance of CdSe QDs and PQT-12 respectively.	106
Figure 5.7:	(a) Absorption profile of both CdSe QDs and PQT-12 and (b) complete absorption of PQT-12/CdSe QDs based self-powered hybrid detector.	108

- Figure 6.1: Schematic device structure of the spectrum selctive self- 115 powered PD depicting reflaction from top metal contacts.
- **Figure 6.2:** (a) J-V characteristics under dark and under light for Schottky **116** photodiode with Au electrode and schematic of device is shown in inset and (b) J-V characteristics under dark and under light for Schottky photodiode with Pd electrode.
- Figure 6.3:(a) Inverse C-V characteristics for Schottky diode with Au118electrode and (b) Inverse C-V characteristics for Schottky diode
with Pd electrode.with Pd electrode.
- Figure 6.4: Time response characteristics of (a) CdSe QDs/ Au and (b) 120 CdSe QDs/ Pd Self-powered Schottky photodiode under the pulsed illumination of white LED light controlled by using Arduino® microcontroller.
- Figure 6.5: Schematic band diagram of ITO/ZnO QDs/CdSe QDs with 121 Schottky contact.
- Figure 6.6:Transmittance of ZnO QDs thin film and Absorption of CdSe122QDs plotted versus wavelength from 350 to 650 nm with the
shaded active region of the device 380 to 610 nm.100 mm.
- Figure 6.7:Current density and responsivity plotted against wavelength for123Schottky diodes with (a) Au and (b) Pd electrode.
- **Figure 6.8:** External Quantum Efficiency (EQE) and detectivity plotted **124** against wavelength for Schottky diodes with (a) Au and (b) Pd electrode.
- Figure 6.9: Incident filed and reflected field depiction in each layer of the 125 device under observation.
- Figure 6.10: (a) Calculated incident power on the CdSe QDs/metal (Au or Pd) interface, (b) calculated total reflected power from the metal interface, (c) measured reflectance of Au and Pd thin films, and (d) calculated refractive index of Au and Pd thin films.
- Figure A.1:Spectrum of white LED light used for device illumination145