# PREFACE

The key motivation of this thesis is to investigate the fabrication and characterization of some ZnO colloidal quantum dots (CQDs) based spectrum selective ultraviolet (UV) photodetectors (PDs). Devices have been fabricated either in the form of interdigitated metal-semiconductor-metal (MSM) structure using glass substrates or in the Schottky diode structure on the silicon substrates by using solution processed ZnO CQDs as the active layer of the UV detectors. The spin-coated ZnO CQDs have been annealed at 450 $^{o}$C for the spectrum selective applications. The spectrum selectivity has been achieved by the quantum confinement of carriers in the ZnO CQDs without using any external filter which is commonly used for Si based spectrum selective photodetectors. The ZnO CQDs have been used in the present study due to their larger surface-to-volume ratio and better performance in terms of the responsivity, spectrum selectivity and response speed another ZnO nanostructure based UV photodetectors. The particle-size dependent electronic and optoelectronic properties of the ZnO CQDs may enable us to tune the peak detectivity wavelength of the detector by fixing the QDs size to the desired value at the time of the synthesis process. Thus the solution processed ZnO CQDs also provide the platform for low-cost low-temperature fabrication of large-area UV photodetectors with narrowband photoresponse characteristics. An attempt has also been made to improve the photoresponse of the ZnO CQDs based MSM UV photodetector by introducing a scattering layer in the device. In this case, a layer of solution processed ZnO nanoparticles (NPs) has been deposited on the interdigitated MSM UV structure fabricated on a glass substrate and UV illumination has been provided from the back side of the device to improve its

responsivity while maintaining fixed spectrum selectivity. The present thesis consists of FIVE chapters which are briefly outlined as the following.

**Chapter 1** presents a brief introduction of the materials, device structures and performance parameters of the photodetectors. A detailed literature survey on various ZnO nanostructure based UV phototdetectors has been discussed. Based on the observations from the literature survey, the scopes of the present thesis have been outlined at the end of this Chapter.

**Chapter 2** reports the synthesis and characterizations of ZnO CQDs prepared by hot-injection method. The optical and electrical properties of Au/ZnO CQDs based Schottky UV photodiode are analyzed. The responsivity and contrast ratio of the photodiode are analyzed. Further, the spectral response and spectrum selectivity of the photodiode has been analyzed between the wavelengths from 250 nm to 800 nm. Further, photodiode also characterized for the rectification ratio, ideality factor and barrier height.

**Chapter 3** investigates the fabrication and characterization of the spin-coated ZnO CQDs based MSM spectrum selective UV photodetector on low-cost glass substrates without using any additional absorption tuning layer. The annealing effect on the ZnO QDs size and irrespective variation in energy band gap corresponding to the change in the annealing temperature from 450ºC and 600ºC at the ambient environment has been analyzed. The spectral response and spectrum selectivity of the photodetector has been analyzed between the wavelengths from 250 nm to 600 nm.

**Chapter 4** also investigates the photoresponsivity and spectrum selectivity of ZnO NPs coated Ag/ZnO CQDs/Ag interdigitated MSM photodetectors of Chapter-3 under front and back illuminations. The ZnO NPs layer can be optimize the photoresponse characteristics of the ZnO CQDs based MSM photodetector by changing the direction of illumination on the device.

**Chapter 5** has been devoted to summarize the major findings of the works presented in various chapters of the thesis. Finally, some future scopes of research in the related area of the thesis are outlined at the end of this Chapter.

----XXX----