PREFACE

Biosensor is an analytical device that consists of a biological component to detect an analyte, coupled with a physical transducer to produce a measureable signal. Biosensors have been widely explored and extensively utilized as a platform for applications in pharmaceutical, environment, food and medical field. Amongst the various classes of biosensors developed so far, cell-based biosensors express promising potential in comprehending fundamental biological processes with reference to a whole cell or a group of cells. The direct use of living cells offers exceptional opportunities for bio-detection and drug discovery. The biochemical effect of the direct spatial contact of living cells is converted into quantitative electrical signals by sensors or transducers, thus bridging the gap between electronics and biology. Cell-based biosensors are endowed with certain advantages in comparison to molecule-based approaches for example, noninvasive long-term recordings, label-free detection, reduced response time, etc. In order to achieve the objectives, the thesis has been divided into following chapters.

Chapter-1 introduces the basics about biosensor and cell-based biosensor; Types of cell-based biosensor currently being used. Different types of cell-based biosensor based on its transduction principle; Strategies for the Design and Characterization of CBB and fundamental behaviour of cells in electric field. Literature review and the observation; Research objective and scope of the present study.

Chapter-2 describes the investigation of functional behaviour of myoblast (C2C12) cells using a co-planar silver metal electrode system integrated to a low-cost ECIS system. Typically, the silver metal was thermally coated on the conversional glass substrate to construct metal-insulator-metal (MIM) structure *via* shadow mask method, to achieve an active layer's dimensions of 1.5 mm wide and 4 mm length. At the same time, to develop a ECIS system, we used the electronic components available at the laboratory to construct a low-cost impedance measuring circuitry and calibrated the developed circuit, against the standard commercial resistor. Further, the MIM device was integrated to the developed impedance measuring circuitry to construct a low-cost ECIS system. To increase the cell adhesion process, the MIM device was coated with 2% gelatin protein and the gelatin-coated MIM device was used as a platform to study the phenotypic change of adherent mammalian cells under the influence of applied electric field. Further, the fabricated biosensor was electrically and optically characterised to validate the outcome.

Chapter 3 focuses on fabrication and characterization of metal-oxide thin film nanomaterials based biosensing devices for assessing dynamic behaviour of adherent mammalian cells. Typically, the Chapter 3 investigates the effect induced by cellular functional behaviour on the characteristic electrical properties of the e-beam deposited aluminium oxide (Al_2O_3) thin film nanomaterial-based metal-insulator-metal (MIM) device. A patterned indium tin oxide (ITO) coated glass substrate having a co-planar electrode dimension of 12×5 mm^2 at each side with a gap of 1 ± 0.2 mm (at center) was used as a transparent electrode system. To fabricate the MIM device, Al_2O_3 thin film of $\sim$100 nm thickness was deposited on ITO electrode system and used as the active sensing interface. To increase the cell adhesion process, the MIM device was coated with 2% gelatin protein and the gelatin-coated MIM device was used as a platform to study the phenotypic change of adherent mammalian cells under the influence of applied electric field. Further, the fabricated biosensor was electrically and optically characterised to validate the outcome.

Chapter 4 investigates the effect induced by cellular functional behaviour on the characteristic electrical properties of the sol-gel synthesized spin coated zinc oxide (ZnO) thin film nanomaterial-based metal-semiconductor-metal (MSM) device. A patterned indium tin oxide (ITO) coated glass substrate having a co-planar electrode dimension of 12×5 mm^2 at each side with a gap of 1 ± 0.2 mm (at center) was used as a transparent electrode system. To fabricate the MSM device, ZnO thin film of ~100 nm thickness was deposited on ITO electrode system and used as the active sensing interface. To increase the cell adhesion process, the MSM device was coated with 2% gelatin protein and the gelatin-coated MIM device was used as a platform to study the phenotypic change of adherent mammalian cells under the influence of applied electric field. Further, the fabricated biosensor was electrically and optically characterised to validate the outcome.

Chapter 5 investigates the effect induced by cellular functional behaviour on the characteristic electrical properties of the sol-gel synthesized spin coated zinc oxide (ZnO) thin film nanomaterial-based larger area heterojunction device. To fabricate the larger area heterojunction device, ZnO thin film of ~200 nm thickness was deposited p-type Si substrate, and to create ohmic contact, the aluminium metal electrode was used on both p-Si and n-ZnO. While, ZnO was used as the active sensing interface. To increase the cell adhesion process, the fabricated heterojunction device was functionalized with poly-L-lysine and the poly-L-lysine functionalized ZnO thin film based extended larger area heterojunction device was further characterized for assessing the cell-induced electrical characteristic property change.

Finally, **Chapter 6** summarizes the major objectives and concludes the major findings of the present thesis. This chapter also outlines some future scope of works related to this thesis.