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Sensors play a decisive role in improving the life of mankind with their extensive applications in the field of medical diagnostics, energy sources like fuel cells, batteries, and solar power, environmental monitoring, and exploring space. Sensors are the analytical devices that detect and translate their physical attributes into readable signals from their surroundings.

Basically, a sensor is composed of two important components viz. an active layer or the recognition and a transducer. Herein, the active layer (or the recognition layer) represents the heart of a sensor, while the transducer converts the change in the environment into an observable signal such as optical, electrochemical, electrical, etc. On the basis of the method of transduction, the sensor can be categorized into physical, chemical, and electrochemical sensors.

The human body introduces itself as the best example of a complex system with numerous sensors capable of selective sensing a wide variety of physical, chemical, and biological quantities. There are particularly five principle sensors that relate to vision, hearing, smell, taste, and feel, that can be used in real-time control systems. In the field of medical diagnostics, sensors have ground in life-saving applications. The application ranges from the identification of types and stages of infection of different diseases in the patient, determining the narrow effective window for different drugs, and regular monitoring of the concentrations of the biomolecules in the biological fluids. As we head into a new decade, thoughts inevitably turn to the future and predictions of what our world will look like in another ten years' time. Technology is changing and growing at a more rapid pace than at any time in our history. With growing technologies and global competition, the risk to human lives and the environment becomes a prime aspect of concern. There is a loss of life expectancy due to environmental health hazards, lethal diseases, and pandemics. In this thesis, we have focused on

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electrochemical sensors since they are associated with a large number of advantages such as excellent sensitivity, high selectivity, great reproducibility, high stability and portability, and they are easy to operate and economical. Nanotechnology in the field of sensors has played a pivotal role in designing advanced sensors with a low detection limit for the analytes as they have a large surface area that provides ease of functionalization and better biocompatibility, selectivity, and sensitivity.

Chapter 1 covers fundamental concepts about sensors, including their components, types, and importance, as well as the use of transition metal nanoparticles and their bimetallic composites in various electrochemical sensing applications, the need to develop the sensor for biomolecules or drugs related to harmful diseases and abnormalities. At last, it also includes the literature survey based on the proposed research topic.

Chapter 2 describes different experimental techniques which have been used for the characterization of synthesized materials. The main techniques which have been employed in characterizations are Field Emission Scanning Electron Microscope (FESEM), High Resolution Transmission Electron Microscope (HRTEM), X-ray Diffractometer (XRD), Energy Dispersive Spectroscopy (EDX), X-ray photoelectron spectroscopy (XPS), Atomic Force Microscopy (AFM) used for the morphological and structural investigation. Cyclic voltammetry (CV), Differential cyclic voltammetry (DPV) and Impedimetric technique (EIS) setup has been used for electrochemical characterization and sensing of the analytes.

Chapter 3 In this work, we present an electrochemical sensor assembled with palladium nanoparticles for the detection of ascorbic acid through Differential pulse voltammetry (DPV), amperometry it curves and electrochemical impedance spectroscopy (EIS). Palladium nanoparticles has been synthesized through wet chemical reduction pathways and has been

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characterized using X-Ray Diffraction technique (XRD), Field Emission Scanning Electron Microscopy (FESEM), High Resolution Transmission electron microscopy (HRTEM), and Energy Dispersive Spectroscopy (EDS). The carbon paste electrode was modified with Palladium nanoparticles and Fc/Fcmc. Ferrocene (Fc) and Ferrocene monocarboxylic acid (Fcmc) was used as a redox couple to sense the respective changes in current and charge transfer resistance (R_{ct}) in phosphate buffer solution of pH 7.0 under similar condition. The fabricated sensor shows a good electrocatalytic response for the sensing of ascorbic acid with a linear range from 10 μM to 500 μM and a detection limit of 5 μM .

Chapter 4 presents an electrochemical sensor based on Cobalt N doped carbon with Palladium nanoparticles (Co-NC/Pd) modified carbon paste electrode for the detection of NADH through amperometry, CV and EIS. Dimethyl ferrocene (Dmfc) was used as a redox mediator to sense the respective changes in current and charge transfer resistance. Co-NC/Pd has been synthesized through hydrothermal synthesis and characterized by XRD, HRTEM, FESEM, EDX and XPS. NADH was determined in PBS at ambient temperature under similar condition. The developed sensor demonstrates an extensively wide linear range (5-1250 μM) and a low limit of detection (2 μM). The developed sensor shows excellent stability, sensitivity, and good selectivity at pH 7.0. The achieved analytical parameters are found to be comparable to or better than previously reported NADH sensors.

Chapter 5 presents an electrochemical sensor based on Ni Palladium nanoparticle decorated on functionalized multi-walled carbon nanotube (Ni-Pd/f-MWCNT) for the determination of dopamine (DA) through amperometry, DPV, and EIS. The Ni-Pd/f-MWCNT was synthesized through chemical reduction approach and characterized by XRD, TEM, HRSEM, EDX, AFM and XPS. Ferrocene monocarboxylic acid was used as redox couple to find the respective

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changes in current and charge transfer resistance (R_{ct}). DA sensing was validated in phosphate buffer and commercially available dopamine hydrochloride injection under similar condition. The fabricated electrochemical sensor shows a wide concentration range (2-400 μM) and a low limit of detection (0.05 μM) and offers a fascinating sensitivity, selectivity, stability, and reproducibility at pH 7.0. The analytical parameters obtained are found to be comparable to or better than previously reported DA sensors.

Chapter 6 summarizes a conclusion of the thesis work and some suggestions for future work.