


Chapter 2

Electrochemical Sensor Applications of Mechanically Alloyed Materials

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ABSTRACT

Development of electrochemical sensors and its research extends over a wide range of applications including clinical analysis, food safety, environmental monitoring, and many more. Electrochemical sensing devices are more convenient for the analytical determination of various electroactive analytes due to its simple fabrication procedure and the reliability in the obtained results. The sensitivity of the electrochemical sensors can be improved by using various chemically modified electrodes instead of traditional unmodified electrodes. Mechanically alloyed materials are one of the fascinating materials used for the modification of electrodes in the development of electrochemical sensors. Metal alloys and their nano porous structures provide good conductivity and high surface area making it more convenient for the sensing applications. The chapter summarizes the analytical characteristics of the mechanically synthesized metal alloys modified electrochemical sensors giving a special emphasis to various dyes, neurotransmitters, biological molecules, drugs, etc. as the target analytes.

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INTRODUCTION

The term ‘sensor’ is indispensable as we come across various sensing devices in diverse areas such as clinical purposes, automobiles, weather forecasting, food sensing, environmental monitoring, pharmaceutical industries, forensics, etc. The sensors are analytical devices that can selectively detect a target analyte, both quantitatively and qualitatively, from a complex matrix by the different types of interaction with the target species and the sensing device (W. Wang, 2016). There are different types of sensors based on the method of operation and their working, and they can be divided mainly into chemical and physical sensors. Physical sensors respond to physical stimuli like temperature, pressure, etc., whereas chemical sensors need stimuli of chemical origin associated with a chemical or biochemical interaction with the target analyte and the sensor. The integral parts of a chemical sensor are the transducer and receptor. The biochemical or chemical interaction of target species occurs via the receptor part of the sensor, and the transducer takes up the chemical energy produced during the exchange. Further, the transducer converts this chemical information into a helpful signal by various operating principles. Based on the signal conversion by the transducers, the sensors are categorized into mass sensitive, optical, magnetic, electrochemical, etc. (Hulanicki et al., 1991).

Among the various types of chemical sensors, electrochemical sensors play a vital role in all aspects of our life, including healthcare monitoring, food safety, detection of various toxic pollutants from environmental samples, etc. (Krishnan et al., 2020)(Antherjanam & Saraswathyamma, 2021; Krishnan & Saraswathyamma, 2021)(Mahale et al., 2022). The electrochemical sensors are highly convenient due to their simple instrumentation, mainly consisting of a working electrode, a reference electrode, and a counter electrode dipped in a supporting electrolyte medium (Shashanka & Kumara Swamy, 2020a). The three-electrode setup is then connected to a potentiostat, and the instrumentation of an electrochemical sensing device is given in Figure 1.

The chemical modification of working electrodes can improve the electrochemical sensors’ sensitivity and analytical performance (Nahirny et al., 2020). Nanomaterials, conducting polymers, metal-organic frameworks, MXenes, metal alloys, various hybrid materials, etc., were used for the chemical modification of electrodes in the fabrication of several electrochemical sensors(Qi et al., 2018)(Aravindan & M.V., 2017)(J. Zhang et al., 2018)(Yu & Breslin, 2020)(Lu, 2019)(Terbouche et al., 2022). (Shashanka & Kumara Swamy, 2020b) Metal alloys are one of the exciting materials for the surface modification of electrodes as these materials act as electrocatalysts for the electrochemical oxidation or reduction of the target analytes (Sakthivel et al., 2019). Mechanical alloying is the process of manufacturing alloyed materials, which was developed in the 1960s to satisfy industrial needs. It is a vastly growing area of

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