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Cutting-Edge Electrochemical Sensors for Endocrine-Disrupting Chemicals Detection

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Abstract

Endocrine-disrupting chemicals (EDCs) such as bisphenol A (BPA), phthalates (DEHP, DBP), polychlorinated biphenyls (PCBs), and per- and polyfluoroalkyl substances (PFAS) present significant health risks, including hormone imbalances, reproductive issues, and cancer. Their detection at very low concentrations in various environments is essential for assessing exposure and mitigating risks. Electrochemical sensors have emerged as a promising solution for rapidly and sensitively detecting these compounds. This presentation will explore the latest advancements in electrochemical sensors designed specifically for detecting EDCs, from recent studies published after 2022.

One of the key advancements is using nanomaterials, such as graphene or carbon nano-tubes, to enhance the sensitivity and selectivity of the electrochemical sensors. These materials provide a high surface area and excellent electrical conductivity, significantly improving detection limits compared to traditional ones [1].

Using molecularly imprinted polymers (MIPs) has also shown great potential for EDCs detection. MIPs are synthetic polymers with specific binding sites that mimic the molecular recognition of natural receptors. MIPs-based electrochemical sensors were, for example, designed for the selective detection of phthalates [2], PFAS [3], and BPA [4]. These sensors achieved high specificity and stability, making them suitable for real-world applications. In addition to material innovations, the design of sensor platforms has also evolved. Microfluidic electrochemical sensors have been developed to enable on-site and real-time monitoring of EDCs in water samples [5]. These platforms permit the rapid analysis of small sample volumes and reduce the overall cost and complexity of the detection process.

Another significant advancement is the application of artificial intelligence (AI) and machine learning (ML) algorithms in interpreting electrochemical sensor data. Incorporating AI techniques can enable the differentiation of target analytes from potential interferences, thus enhancing the overall performance of the sensors [6].

The future of electrochemical sensors for EDCs detection lies in further enhancing their sensitivity, specificity, and practicality. Continued interdisciplinary research is essential, particularly in developing new nanomaterials, combining electrochemical sensors with Internet of Things (IoT) technologies to enable real-time data collection and remote monitoring, designing sensors that are easy to use for non-specialists to facilitate widespread adoption in various settings, mainly natural environments, and

ensuring that new sensors meet regulatory standards for environmental monitoring and public health.

Keywords: Electrochemical Sensors, Endocrine-Disrupting Chemicals.

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