

Electrochemical sensors, enhanced by nanomaterials (NMs) like carbon nanofibers and metal nanoparticles, are crucial for detecting heavy metals in water and food. Sensor performance depends on factors such as sensitivity, detection limit, and stability, improved through surface modifications (drop casting, SAMs, etc.). Nano-enzyme catalytic activity is influenced by external (pH, electrolyte) and intrinsic (size, shape) factors. Signal transduction at the nanoscale interface is vital for sensor efficacy. Rapid electrochemical and colorimetric nanosensors enable real-time, on-site detection, improving accessibility. Heavy metal contamination poses serious health risks due to bioaccumulation, necessitating accurate detection. Electrochemical sensors offer low detection limits and versatile signal reporting. Diverse analytical techniques (potential analysis, conductometry, colorimetry) provide rapid, sensitive, and cost-effective detection. Waste-derived carbon nanodots (CNDs) offer a sustainable approach for heavy metal detection, combining fluorometric and electrochemical capabilities. Novel zeolite-clay composite membranes, made from inexpensive materials, show promise for heavy metal removal, with electrochemical investigations optimizing their performance. Porous organic frameworks (POFs) further enhance sensor sensitivity, selectivity, and stability, enabling the development of portable and cost-effective devices for environmental monitoring.