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Selective detection of alpha synuclein amyloid fibrils by faradaic and non-faradaic electrochemical impedance spectroscopic approaches

Abstract

This study utilized faradaic and non-faradaic electrochemical impedance spectroscopy to detect alpha synuclein amyloid fibrils on gold interdigitated tetraelectrodes (AuIDTE), providing valuable insights into electrochemical reactions for clinical use. AuIDE was purchased, modified with zinc oxide for increased hydrophobicity. Functionalization was conducted with hexacyanidoferrate and carbonyldiimidazole. Faradaic electrochemical impedance spectroscopy has been extensively explored in clinical diagnostics and biomedical research, providing information on the performance and stability of electrochemical biosensors. This understanding can help develop more sensitive, selective, and reliable biosensing platforms for the detection of clinically relevant analytes like biomarkers, proteins, and nucleic acids. Non-faradaic electrochemical impedance spectroscopy measures the interfacial capacitance at the electrode–electrolyte interface, eliminating the need for redox-active species and simplifying experimental setups. It has practical implications in clinical settings, like real-time detection and monitoring of biomolecules and biomarkers by tracking changes in interfacial capacitance. The limit of detection (LOD) for normal alpha synuclein in faradaic mode is 2.39-fM, The LOD for aggregated alpha synuclein detection is 1.82-fM. The LOD for non-faradaic detection of normal alpha synuclein is 2.22-fM, and the LOD for nonfaradaic detection of aggregated alpha synuclein is 2.40-fM. The proposed EIS-based AuIDTEs sensor detects alpha synuclein amyloid fibrils and it is highly sensitive.

Keywords

Amyloid alpha; Amyloid fibrils; Biosensor; Electrochemical impedance; Parkinson's disease