Sensitive electrochemical detection of small structural changes of proteins.

Veronika Ostatná, Peter Šebest, Marek Zelinka, and Hana Černocká

Institute of Biophysics, The Czech Academy of Sciences, v.v.i., Královopolská 135, 61265, Brno, Czech Republic
† corresponding author's email: ostatna@ibp.cz

Proteins, as essential components of life, are the focus of a wide array of research fields. Understanding their behavior is crucial, for instance for advancing diagnostic methodologies and medical treatments. Given that numerous biochemical processes occur at membrane-liquid interfaces, electrochemical analysis emerges as a powerful approach for studying biomolecules at charged liquid|electrode interfaces.

Electrochemical methods offer a powerful and rapid approach for probing protein structural dynamics and interactions with biomolecular partners such as DNA, other proteins, and peptides [1, 2]. These techniques are highly sensitive to subtle conformational changes, particularly under conditions of surface polarization to highly negative or positive potentials, where partial unfolding or denaturation may occur. The charged surface plays a crucial role in this type of analysis since the proteins are accumulated at the uncharged surface, where they retain their folded structures. Subsequently, electrode polarization to negative/positive potentials can lead to structural change in an extreme case to denaturation/unfolding [3]. Even minor conformational protein changes can influence protein stability at charged interfaces, altering the accessibility of electroactive groups and thereby modulating the electrochemical signal [2]. This approach enables differentiation between monomeric and dimeric protein forms as well as the analysis of weak biomolecular interactions, such as those between lectins and carbohydrates [4, 5].

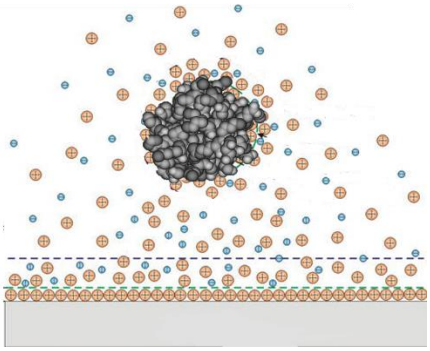

Figure 1: Protein at liquid|electrode interfaces

References

[1] V. Ostatná, H. Cernocká, T. Galicová, S. Hason, Electrochemical analysis of proteins important in cancer: Behavior of anterior gradient receptors, p53 protein and their complexes at charged surfaces, Current Opinion in Electrochemistry, 39 (2023) 101269.
[2] E. Palecek, J. Tkac, M. Bartosik, T. Bertok, V. Ostatna, J. Palecek, Electrochemistry of nonconjugated proteins and glycoproteins. Toward sensors for biomedicine and glycomics, Chemical Reviews, 115 (2015) 2045-2108.
[3] V. Ostatna, R.M. West, Effects of ex situ chronopotentiometric analysis on stability of bovine serum albumin on mercury electrodes, J. Electroanal. Chem., 860 (2020) 113884.
[4] T. Galicová, S. Hasoň, V. Ostatná, Interaction of lectin *Sambucus nigra* with sialylated trisaccharides in the presence of osmolytes. Chronopotentiometric sensing, Bioelectrochemistry, 152 (2023).
[5] T. Staronová, J. Holcáková, P. Vonka, R. Hrstka, V. Ostatná, Impact of galectin-1's redox state on its lectin activity and monomer-dimer equilibrium. Focusing on oxidized Gal-1, Int. J. Biol. Macromol., 295 (2025).