Electrode Materials: The Decision Makers of the Electrochemical Properties of Immobilized Human Liver Microsomes

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Protein film electrochemistry (PFE) enables the investigation of electron transfer and catalytic properties of proteins, free from diffusion barriers, and provides mechanistic insights about the catalytic and redox active sites. In PFE, the primary objective involves the immobilization of protein on an electrode surface in such a way that the conformation and activity are retained. PFE requires only a tiny amount of protein (a μL to few μL in the concentration range 1-3 mg mL^{-1} is sufficient for an electrode area of 0.2 cm^2) and provides the opportunity to explore a wide variety of surface chemistries to suitably immobilize and investigate proteins/enzymes.

The field has received tremendous interests among electrochemists and recently the usability of crude cellular/sub-cellular fractions instead of purified enzymes on electrodes have been explored to screen drugs. The type and surface nature of electrode materials may directly influence the redox and catalytic activity of an immobilized protein film. Studying the liver microsomes (fragmented endoplasmic reticulum containing membrane bound drug metabolizing monooxygenases and their oxidoreductases) by PFE has received a great deal of attention presently, owing to the major role of liver in drug and xenobiotic metabolism.

In this work, for the first time, we present our findings on the *direct influence* of different electrode materials on the electrochemical and catalytic kinetics, and stability of immobilized human liver microsomes (HLM), at a *monolayer or sub-monolayer* level. The edge plane (EPPG), basal plane (BPPG) and high purity pyrolytic graphite (HPPG), glassy carbon (GCE), gold, and ITO electrodes are chosen for this study. We have determined that the average electron transfer rate constant (k_s, s^{-1}) of oxidoreductases in HLM films is in the following order: GCE (81 ± 11 s^{-1}) > HPPG (59 ± 5 s^{-1}) > EPPG (36 ± 4 s^{-1}) ≈ BPPG (33 ± 8 s^{-1}). The electrocatalytic studies of these HLM films are underway. The knowledge obtained from this study will aid in developing single-step, rapid, and cost-effective novel electrochemical biosensors and bioreactors.

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