

Electrochemical Sensing coupled to Liquid-Liquid Phase Extraction using Hydrophobic Deep Eutectic Solvents

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In-field measurements of hydrophobic biomarkers have gained increasing attention in clinical research. For instance, the detection of hydrophobic quinones, usually employed as biological key molecules in the redox machinery for photosynthesis and respiration, set up also the chemical entity of antibiotics, cofactors and vitamins.¹ However, their sensitive and selective analysis is challenging due to their low solubility in aqueous solutions.² Amperometric electrochemical sensing exhibits an auspicious approach owing to portable equipment, low limit of detections (LoDs, micromolar) and the direct conversion of the target signal into an electrical signal, allowing miniaturization and thus small sample volume (microliters).³ However, real-world samples typically contain a wide range of redox-active molecules and, unless equipped with bioreceptors, the selectivity and specificity of the resulting abiotic sensor is often inadequate. Moreover, the very low upper concentration limit of hydrophobic biomarkers, which may be below the sensor's own LoD, prevents the detection in aqueous solutions.

Here, we propose an approach based on the electrochemical sensing of prototypical quinone/hydroquinone (Q/H₂Q) redox couples interconnected to liquid-liquid phase extraction (LLPE) using Hydrophobic Deep Eutectic Solvents (HDES). HDES are promising environmental benign quasi-water immiscible solvents formed by mixing a hydrogen bond acceptor (e.g., decanoic acid (DA)) and a hydrogen bond donor (e.g., *tetra*-butylammonium chloride (TBACl)) in an appropriate molar ratio. Since one of the precursors is ionic, the LLPE can subsequently be coupled with electrochemistry. By using drop-size volume of the HDES as extractant, which is brought into contact with a larger amount of sample, fast extraction equilibria and high preconcentration factors are reached. Thus, beforehand inaccessible concentrations are enriched via preconcentration and become electrochemically accessible. In addition, hydrophobic analytes are preferably extracted so that enrichment comes along with both, an increase in specificity and lower LoDs.

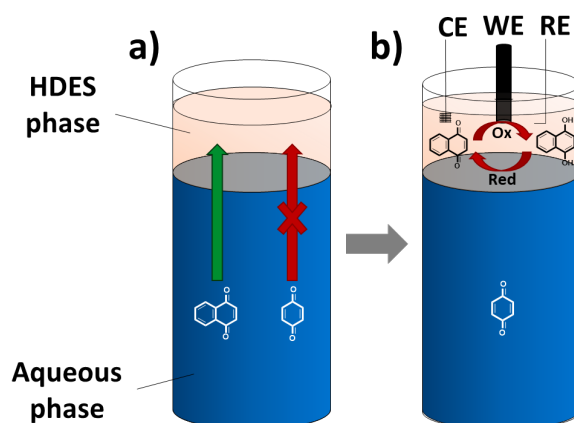


Fig. 1: a) Schematic representation of the selective partitioning of hydrophobic naphthoquinone prior hydrophilic benzoquinone via LLPE using HDES and b) subsequent electrochemical sensing.

[1] Soyoung Kim, R., *et al.*, *Bull. Korean Chem. Soc.*, **2014**, 35(11), 3143.

[2] Panahi, Z. *et al.*, *Sens. Actuators. Rep.*, **2021**, 3, 100051.

[3] He, Q. *et al.*, *Materials Today Advances*, **2023**, 17, 100340.