

UNIVERSITY OF RHODE ISLAND
Department of Chemistry Ph.D. Seminar

2:00 PM, Friday, March 31, 2023
Beaupre Room 105

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***Single-Entity Electrochemistry of
Nanoemulsions: from Fundamental
Understanding to Practical
Application***

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Single-Entity Electrochemistry of Nanoemulsions: from Fundamental Understanding to Practical Application

This presentation introduces a unique application of single-entity electrochemistry (SEE) to provide a fundamental understanding of nanoemulsions (NEs) and practically utilize NEs for ultra-trace level electroanalysis. Inherently, the inner phase of NEs is hydrophobic, which enables NEs to extract and encapsulate hydrophobic components from aqueous bulk solutions. This property makes NEs versatile nanocarriers in food, cosmetic and pharmaceutical industries. Accordingly, the partition coefficient, P at intact NEs is a crucial physicochemical property to determine the carrying amount of target molecules. However, P has not been explicitly measured at intact, individual NEs by currently available analytical techniques, which are based on ex-situ measurements. Herein, we uniquely employ SEE to accurately determine P *in situ* at intact individual NEs. Synthesized NEs with Pluronic-F127 as surfactants and dioctyl sebacate (DOS) as plasticizers are dispersed to extract 2-aminobiphenyl (2-ABP) dissolved in water. SEE is employed to *in situ* estimate 2-ABP partitioned to each individual NE, while the oxidation of 2-ABP is monitored upon the collision of single NEs with a Pt ultramicroelectrode. Our measurements, for the first time determined the P at individual NEs as $1.9 (\pm 1.4) \times 10^{10}$, which was further validated by molecular dynamic simulations. In this simulation, we revealed that intermolecular interactions between partitioned ABP and DOS (NE inner component) facilitate the unprecedentedly large P via non-covalent bonding. The analytical utility of NEs and SEE are further elucidated for ultra-trace level analysis. We employed NEs to efficiently separate/extract and preconcentrate ferrocenemethanol (FcMeOH) as a model of ubiquitous aromatic toxicants dissolved in aqueous solution, where SEE allowed us to sense and quantify the extracted FcMeOH to each NE in real time. From the quantitative analysis, we could obtain a detection limit of sub-ppb level, comparable to highly sensitive inductively coupled plasma-mass spectrometry. Our newly demonstrated approach with high sensitivity, rapid response, and easy accessibility will be strengthened by selectivity factors inside NEs, and extended for environmental and biomedical applications.