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Preface to Special Issue on Single-Entity Electroanalysis

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PREFACE
单个体电分析专辑序言

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化学测量领域的核心挑战之一是实现对单个体（如单个细胞、单个纳米粒子、单个纳米气泡、和单个分子等）超高灵敏检测。电化学是测量单个体电子传递过程最直接最有效的手段之一。通过高时间分辨和高电流分辨的电化学测量能够对微纳尺度界面上的电化学反应进行精准分析，获取每一个单体的特征电信号，解析被平均效应掩盖的个体间差异。目前，已有超微电极以及包括纳米管、纳米尖和纳米孔道等在内的多种纳米结构被应用于构建高空间分辨率与高灵敏的单个体电化学传感界面，提供了与单个分析物尺寸匹配的电化学测量界面。同时，随着高时间分辨微弱电流测量仪器的发展，单个体电分析化学技术可实时追踪亚毫秒至微秒级的单个体动态电化学反应过程。基于此，对溶液体系中每一个待测物的高通量、快速电化学灵敏测量，有助于识别稀有亚群个体、发现化学反应隐藏中间体、追踪动态相互作用及反应路径。例如，面向生物分子的单分子水平纳米孔道电化学测序与分析，可应用于疾病的早期精准诊断；面向电活性纳米材料的单颗粒水平电化学测量，可准确揭示纳米材料的构效关系、反应过程及异质性信息；面向单个细胞的原位电化学分析，能够探索细胞内外和细胞间的生化过程，更好地理解细胞间网络通讯机制。近年来，单个体电化学测量技术在测量界面、测量仪器及测量数据分析方面取得了一定的发展，为微纳材料、生命分析以及能源催化等领域的研究提供了测量新工具。

《单个体电分析》专辑（2024 年第 10 期和第 11 期）汇集了在国内外单个体电分析领域具有丰富研究经验团队的前沿成果，共刊载了 5 篇论文，包括 2 篇综述论文和 3 篇研究论文。专辑涵盖了诸多创新性工作，如 $Au@WS_2$ 纳米电极上单个纳米气泡的形成与分析、用于单个细胞精确递送的纳米孔道电化学技术、金属有机框架功能化的固态纳米通道对锶离子的高灵敏检测、基于铂纳米粒子的碰撞电化学用于乳腺癌 MCF-7 细胞的快速检测以及液 - 液界面单个体碰撞电化学研究等。愿借此专辑，为读者了解和深入开展单个体电分析领域的研究提供参考，以期为推动我国单个体电分析技术的进一步发展贡献绵薄之力。

我们衷心感谢为本专辑撰稿的研究者们的大力支持和贡献，并对审稿人和编辑部老师们的无私付出和辛勤劳动表示诚挚的感谢！

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The precision and depth of our understanding push the chemical measurement is to achieve high sensitive detection of single entities, e.g., single cells, single nanoparticles, single nanobubbles, and single molecules. Electrochemistry stands out as ha direct and effective method for measuring electron transfer processes. High-resolution electrochemical measurements enable precise analysis of redox reactions at micro/nanoscale interfaces, yielding unique electrochemical signals from each entity, and revealing hidden inter-individual differences that are often covered by averaging effects. Various nanostructures, including ultramicroelectrode, nanopipette, nanotip, and nanopore, have been developed to construct electrochemical sensing interfaces that match the size of individual analytes with high spatial resolution and high-sensitivity. Advances in instrumentation enable the high temporal resolution and weak current detection, facilitating the real-time monitoring the dynamic electrochemical processes ranging from sub-milliseconds to microseconds. This capability supports the high-throughput and rapid sensing in solution, enabling identification of rare subpopulations, discovery of reaction intermediates, and mapping of dynamic interaction pathways. For example, nanopore technologies enable single biomolecule sequencing and sensing that can be applied to early and precise diagnosis. Electrochemical measurements at the single-particle level reveal intrinsic heterogeneity of structure-activity relationship for nanomaterials. In-situ electrochemical analysis of individual cells also provide insights into intracellular and intercellular biochemical processes while enhancing our understanding of mechanisms related to cell-to-cell communication networks. In recent years, significant advancements have been made in single-entity electrochemical measurements, including developments in nanointerfaces, ultrasensitive instrumentation, and intelligent data analysis, providing new tools for the studies in micro-/nanomaterials, life sciences, and energy catalysis.

The Single-Entity Electroanalysis special issue (2024, Issues 10 and 11) brings together cutting-edge research from teams with extensive experience in single-entity electroanalysis field, featuring five papers, including two review papers and three research papers. This issue covers a range of innovative work, such as "Single Nanobubble Formation on Au Nanoelectrodes and Au@WS_2 Nanoelectrodes: Voltammetric Analysis and Electrocatalysis", "Precision Delivery Using Nanopipette for Single-Cell Studies", "Highly Sensitive Detection of Strontium Ions Using Metal-Organic Frameworks Functionalized Solid-State Nanochannels", "Platinum Nanoparticle-Based Collision Electrochemistry for Rapid Detection of Breast Cancer MCF-7 Cells", "Single-entity collisional electrochemistry (SECE) at the micro- and/or nano-interface between two immiscible electrolyte solutions (ITIES)".

We hope this special collection will provide the knowledge to the readers for conducting in-depth studies in single entity electrochemistry in China. With this preface, we would like to express our heartfelt thanks to all the authors, reviewers and editorial staff for their hard and fruitful work!