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Encouraging More Frogs in Electrochemistry

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《电化学研究方法》专辑序言

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正确、规范和严谨的研究方法,是科学工作者获取真实数据、做出正确判断的重要保障. 二十多年来国家数次发生突发性疫情,倘若有正确、规范和严谨的研究方法和检验流程,避免在发病初期产生误判而及时采取隔离治疗措施,何至于造成巨大的国家资源浪费和社会恐慌,甚至付出生命的代价?

电化学何尝不是如此? 电化学研究电能和化学能之间的相互转化规律,被视为实现全球能源与环境可持续发展的不可或缺的解决方案. 随着科学技术日新月异的进步,电化学技术日益工具化,电化学研究群体迅速膨胀. 然而,电极反应及其偶联的反应物、离子和电子输运过程,决定了电化学的能量转化效率和器件性能;各分步过程的复杂机理及其相互交织耦合的特性,使电极过程的复杂程度并不亚于复杂生命过程. 倘若没有正确、规范和严谨的研究方法,电化学学科的发展将举步维艰.

电化学体系的性质是客观存在,各种不同的研究方法应该殊途同归,获取可比对的、相互验证的实验数据. 然而,即便是同一体系,可查考的文献报道却呈现出"横看成岭侧成峰,远近高低各不同"的风景. 其中典型的案例包括:(1) 大多数高性能电催化材料——例如氧还原和二氧化碳还原催化剂——并未在器件层面上表现出相应的高活性;(2) 各种谱学技术所检测到的吸附物种的作用机制——例如扮演反应中间体、不参与反应的旁观者或者占据催化位点的毒化物——电化学界依然存在诸多争议;(3)基于密度泛函理论计算和反应中间物吸附能的热力学判据,在预期能量-物质转化的电催化反应活性时,在火山顶区域屡屡失效.

上述等等问题,引起了中国电化学会及电化学前辈科学家们的高度重视. 近年来,全国电化学会议开设会前培训讲座,厦门大学举办"电化学研究方法暑期学校",组织全国优秀专家开设电化学研究方法专题讲座,力图重建正确、规范和严谨的研究范式,避免电化学工作者在科学研究实践中得出"瞎子摸象"式的片面结论. 考虑到相关培训的体量有限, 为了让更多的新进青年才俊更快更好地掌握正确的电化学研究方法学,在《电化学》主编孙世刚院士和各相关领域专家的大力支持下,我们拟在今后几期《电化学》期刊上介绍能源电化学体系常用的理论与实验方法学及其正确应用.

"工欲善其事,必先利其器". 建立结构确定电极材料的可控制备方法学以及模型材料体系的构筑平台,发展准确地定量分析电极过程的仪器方法学,是获得可靠实验数据、提出电化学理论的前提. 本专辑录用的 6 篇文章系统地总结了可控制备结构确定电极材料的实验方法学,以及在结构确定电极材料上发生的电极过程的反应机理与动力学性质的理论和实验方法学, 介绍了最新进展并展望了未来发展趋势. 希望本专辑的发表,能够起到抛砖引玉的作用,让电化学同仁了解本领域的发展现状、发展趋势和存在的问题,吸引更多电化学同仁关注方法学并在各类学术期刊上分享在"发展新型表征与计算技术、克服已有技术中的挑战与困难"方面的经验. 让我们共同努力,为揭示电极过程动力学规律、建立相关电化学理论提供可靠的实验数据,为推动电化学能源转换技术的规模商业化进程提供有力支撑.

最后,对本专辑所有作者、审稿人及编辑部工作人员卓有成效的工作和辛勤的劳动表示衷心的感谢!

Encouraging More Frogs in Electrochemistry

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"Some mathematicians are birds, others are frogs." This is the opening of a famous article written by Freeman Dyson (Dyson, Freeman. "Birds and frogs." *Notices of the AMS* 56.2 (2009): 212-223). He continues: "Birds fly high in the air and survey broad vistas of mathematics out to the far horizon." and "Frogs live in the mud below and see only the flowers that grow nearby." Hilbert, who listed twenty-three outstanding unsolved problems that shape the course of mathematics in the past century, is a prototypical bird. Yitang Zhang, who targets horrendously difficult problems and recently made a decisive step to prove the Twin Prime Conjecture, is an exemplary frog.

This metaphor also applies to electrochemistry, an important research field that is both broad and deep. John O'M. Bockris is an electrochemical bird, who was vigorously engaged in writing/editing comprehensive textbooks of electrochemistry that have influenced generations of electrochemists. Wolfgang Schmickler, Richard Compton, and Juan Feliu are electrochemical frogs, who delight in solving one problem at a time using particular tools that they know very well and collecting beautiful flowers when traveling in unexplored territories.

As Dyson pointed out, it is inappropriate to say that birds are superior to frogs because they see farther, or frogs are superior to birds because they see deeper. A healthy research field needs both birds and frogs. It is tempting to think that the hybrid of birds and frogs is most beneficial to the development of a research field. However, there is no guarantee that the resultant hybrid delights in in-depth thinking and has broad vision. The hybrid may go in the unintended direction that cannot fly high enough to see the broad vistas and is reluctant to live under the ground. In the latter scenario, the research community will be full of undesirable buzzing noise.

As we all know, the current paradigm of electrochemical research favors combining as many different tools as possible, maximizing the impact of a finding to societal needs as much as possible, and raising new concepts unifying different research activities as broad as possible. The original intention is to grasp the whole picture, to arouse public consciousness, and to unify our thinking. However, it may end in an unexpected way: the obtained picture is loose as none of the tools is appropriately and adequately implemented, the claims are over-exaggerated, and the concepts are unsubstantial.

Currently, the research atmosphere is unfriendly to frogs that delight in solving one problem at a time using a particular tool. Their publications are less read, and resources less granted. Consequently, there is growing consensus to encourage and cultivate more frogs for the sake of the health and sustainability of electrochemistry. In an effort in this direction, the Chinese Society of Electrochemistry supported a series of tutorial sections in a national meeting of the society. Moreover, Xiamen University has successively held summer schools with specific topics as themes. Bearing the same belief in mind, the Chinese Journal of Electrochemistry arranges this topical issue, contributed by frogs in this field, as a joint force in parallel with existing measures.

Electrochemistry needs birds.

Electrochemistry also needs frogs.

But, electrochemistry needs more frogs than birds.