The Organic and Biological Electrochemistry Division

by Jean Lessard

Our Featured Division

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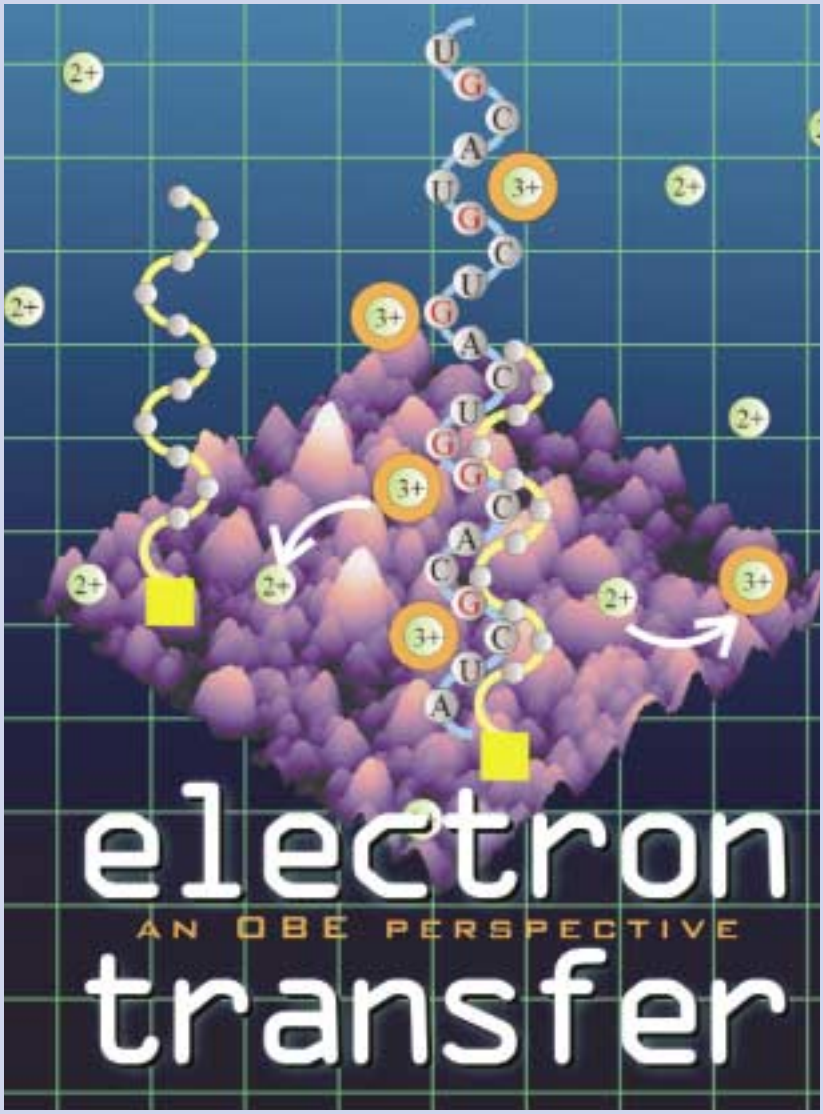

The Organic and Biological Electrochemistry Division (O&BE) celebrated its 60th anniversary as a Division of The Electrochemical Society in the year 2000. The Division was originally called the Electro-Organic Division and was renamed the Organic and Biological Electrochemistry Division in 1972 to reflect the growing interest of its members in bioelectrochemistry and the increasing importance of this field of research and applications (see Ref. 1 for a brief historical account of the Division). The O&BE Division has now over 800 active members spanning Asia, Europe, North America, and South America. Since 1972, the choice of officers (chairman, vice-chairman, and secretary-treasurer) is made alternately from areas in organic electrochemistry and bioelectrochemistry. The officers are elected during the business meeting of an odd-numbered year. The Division's business and executive meetings are held once a year during the spring Society meeting. Six members-at-large (three organic electrochemists and three bioelectrochemists) are elected to serve on the executive committee. There are two working groups, one in organic electrochemistry and the other in bioelectrochemistry, each chaired by a member-at-large. Their main tasks are to recruit young members, to foster their participation in O&BE symposia, and to define topics for future symposia. The O&BE Division has recently joined other Divisions in awarding memberships and travel grants to students. The resources to support students and young speakers come from the publication of symposium proceedings volumes and the collection of Divisional dues ($5). A Divisional award was established in 1992 for "outstanding scientific achievements in the electrochemistry of organics" in honor of Manuel M. Baizer (officer of the Division from 1971 to 1977). Baizer was the inventor of the most important commercial organic electrochemical process, namely, the cathodic conversion of acrylonitrile to adiponitrile

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(precursor of nylon). The Manuel M. Baizer Award, co-sponsored by The Electrosynthesis Company and Monsanto, is presented at the spring meeting of even-numbered years and consists of a scroll, a prize of $1,000, and some travel assistance. The award lecture is delivered at the biannual International Manuel M. Baizer Symposium. The scroll and prize are presented at the Baizer reception usually held on Wednesday evening. The list of recipients can be found on the ECS website at www.electrochem.org/awards/baizer.htm or http://publish.uwo.ca/~mworkent/OBEecs/.

In the first issue of *Interface* featuring the O&BE Division (winter 1997),[2] Frank Schultz (officer of the Division from 1993 to 1999) defined very well the mission of the O&BE Division: "to encourage education, training, research, and publication in subjects related to electrochemical reactions of organic compounds and bioelectrochemistry and to cooperate with other Divisions of the Society in extending scientific knowledge of mutual interest." This mission is accomplished through attractive and timely symposia. The biannual International Manuel M. Baizer Symposium attracts a large audience (a three- to four-day symposium with 40 to 65 oral presentations) and covers all areas of organic electrochemistry: synthetic organic, mechanistic organic, and analytical organic electrochemistry. Symposia have been held in the last few years on various aspects of organic and biological electrochemistry: electrosynthesis, industrial electro-organic chemistry, organometallic electrochemistry, electrode processes (direct and mediated electron transfer), modified electrodes, conductive polymers, biomass conversion, chemical sensors, biosensors, electron transfer processes in biological systems. Following are examples of titles of symposia held over the last 10 years: Advances in Electro-Organic Synthesis; Electrochemistry in the Preparation of Fluorine and its Compounds; Scale-up in Organic and Pharmaceutical Electrosynthesis; Organic Electrode Processes and Reaction Mechanisms; Mechanistic Organic and Organometallic Electrochemistry; Reactive Intermediates in Organic and Biological Electrochemistry; Conductive Polymers and Surface Modified Electrodes; Biomass Electrochemistry; Spectroelectrochemistry and Electroanalysis; Bioanalytical Electrochemistry; Chemical and Biological Sensors and Analytical methods; DNA Sensors; Electron-Transfer Reactions in Biological Systems; Applications of Electrochemistry in Electrophysiology and Medical Therapy; Electrochemistry of Cells and Organelles; Compatibility of Biomedical Implants; and others. Some of these symposia were organized by the Division and others, particularly those related to sensors and bioelectrochemistry, were co-sponsored symposia involving the O&BE Division and other Divisions of the Society and/or the New Technology Subcommittee. The above list of symposia illustrates the diversity of interests of Division members and the breadth and vitality of organic electrochemistry and biological electrochemistry. In *A Centennial History,* published by the Society,[1] Petr Zuman (ECS Fellow and officer of the Division from 1981 to 1987) gave a very interesting overview of the various areas and topics of interest to the Division members as

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well as an insight into some new opportunities for organic and biological electrochemistry. The development of "green" and selective chemical processes using electrochemistry and bioelectrochemistry (electrochemically driven enzymatic syntheses) and a deeper understanding of important life processes are examples of new opportunities.

In the winter 1997 issue of *Interface* featuring the O&BE Division, the emphasis was put on "how to generate chemical products with greater selectivity using electrochemistry and how to target electron transfer with greater control and selectivity."[2] This was illustrated by four articles: on electrochemical enzyme catalysis by proteins incorporated in films of surfactants,[3] on rapid electron transfer at functional electrode surfaces (surface-containing chemical functionalities which interact selectively with biological molecules),[4] on fundamental aspects of electron transfer between an electrode and a protein confined at or near its surface;[5] and on the electrosynthesis of optically active intermediates (asymmetric electrosynthesis).[6]

This issue of *Interface* contains three articles that illustrate further the breadth and over-reaching nature of organic electrochemistry and biological electrochemistry. The first article by Holden Thorp of the University of North Carolina at Chapel Hill and Natacha Popovich of Xanthon is about signal amplification for electrochemical detection of nucleic acids on solid supports, and reviews the state of the art in electrochemical detection of nucleic acids. The paper begins with an overview of methods for detecting DNA on solid surfaces, particularly the work of Mikkelsen, Wang, and Hashimoto. The paper then highlights the use by Kuhr of copper electrodes to perform oxidation of nucleic acid sugars, producing a significant signal enhancement for polynucleotides in flowing streams. The bulk of the paper focuses on three systems that involve hybridization of nucleic acid targets to modified electrodes with detection schemes that provide enhancement of the electrochemical signal. The first is the work of Barton where a solution-based anionic redox couple is used to achieve catalytic signal enhancement on thiol-modified gold. The second system is that of Kayyem where AC voltammetry is used in conjunction with a signal probe modified with multiple ferrocenes to effect a higher signal. The final system developed by one of the authors uses catalytic oxidation of guanine by Ru(III) on modified ITO surfaces to achieve sensitive detection of polynucleotides containing a high number of guanine residues. The authors also discuss prospects for the future in diagnostics and genomics.

The second article by R. Daniel Little of the University of California at Santa Barbara and Kevin D. Moeller of Washington University illustrates the power of electrochemistry as a tool for synthesis. Because electrochemistry allows for the selective introduction and removal of electrons from organic molecules, it is an ideal tool for reversing the polarity of known functional groups and triggering umpolung reactions. For example, electrons can be added to electron-poor functional groups to convert them from electrophiles into nucleophiles or removed from electron-rich functional groups to convert them from nucleophiles into electrophiles. The ensuing reactive intermediates can then be trapped to complete reactions that involve the net coupling of either two electrophiles or two nucleophiles. Such reactions are intriguing because their availability creates the potential for developing entirely new synthetic strategies for the construction of complex molecules. The paper provides a short (non-comprehensive) overview of recent developments that point the way to what can be accomplished using synthetic electrochemistry in the future.

The third article by Flavio Maran of the University of Padova and Mark S. Workentin of the University of Western Ontario addresses fundamental aspects of dissociative electron transfer, *i.e.* those reactions in which electron transfer causes or is even concerted to the cleavage of a sigma bond. The paper describes how to predict the rate of these reactions as a function of driving force, which can be easily varied by modulating either the applied potential or the $E°$ of the solution electron donor. The issue of how to distinguish between the possible mechanisms, by using concepts such as reorganization energies and transfer coefficient, is outlined and also considered in view of its possible relevance in exploiting these reactions for both fundamental and applied purposes. The similarities and differences between intermolecular and intramolecular dissociative electron transfer as well as the possible cleavage pathways are also discussed. The main goal of this overview is thus to provide a short account of the most relevant work carried out in the field and to outline possible future developments. The leading role of scientists who are well known and active in the O&BE Division is particularly stressed.

The O&BE Division hopes that these articles, and those in the previous *Interface* issue featuring the Division, help emphasize the broad range of interests and the great potential for future growth of organic electrochemistry and biological electrochemistry. We hope that these articles will spark your interest in the fields and in the Division. The members of the executive committee will be most happy if you contact them to express your interest, attend the Baizer Award reception (even-numbered years), and the Divisional luncheon at each spring meeting. ■

References

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2. F. A. Schultz, *Interface*, **Vol. 6**, No. 4, p. 25 (1997).
3. J. F. Rusling, *Interface*, **Vol. 6**, p. 26 (1997).
4. I. Taniguchi, *Interface*, **Vol. 6**, p. 34 (1997).
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6. S. Torii, *Interface*, **Vol. 6**, p. 46 (1997).

About the Author

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