How Do We Learn Electrochemistry?

by Jeffrey W. Fergus

The importance of electrochemistry is undeniable—we literally cannot live without electrochemistry for proper cell function and transmission of signals through the nervous system. Electrochemistry is also vital in a wide range of important technological applications. For example, batteries are important not only in storing energy for mobile devices and vehicles, but also for load leveling to enable the use of renewable energy conversion technologies. Electrochemistry is involved in the production of materials by electrorefining or electrodeposition as well as the destruction of materials by corrosion. In spite of its ubiquity there are very few formal educational degree programs in electrochemistry.

If electrochemistry is ubiquitous, but formal educational programs are rare, how do the scientists and engineers working on electrochemical products and processes learn the electrochemistry they need? A recent survey of ECS members indicated that a little less than half (45%) of the more than 500 respondents had taken a formal course in electrochemistry or electroanalytical chemistry. A majority of respondents had taken courses in other subjects, such as chemistry or corrosion, that covered electrochemistry, but in approximately half of those courses, electrochemistry was judged to comprise less than 10% of the course. These results reflect electrochemical education worldwide as the responses were relatively evenly distributed between individuals educated in the U.S. (46%) and outside the U.S. (54%). The results also reflect current and past educational programs since responses were received from individuals with from zero to more than 60 years of experience (Fig. 1). The proportion of respondents with five years or less experience having taken a course in electrochemistry (51%) was slightly higher than that for respondents with more than 5 years of experience (43%), which suggests that coverage of electrochemistry may be increasing. Nonetheless, there are still individuals working on electrochemical devices or processes from disciplines in which they received little or no formal education in electrochemistry. The lack of academic programs in electrochemistry provides the impetus for professional societies to help individuals obtain the knowledge needed to address the electrochemical aspects of their work.

One of The Electrochemical Society's three objectives is "to assure the availability of adequate training and education of fundamental and applied scientists and engineers in these fields" (these fields being electrochemistry, solid-state science, and allied subjects), which demonstrates the Society's commitment to meeting educational needs in electrochemistry. This is not the first issue of *Interface* to focus on education. The fall 2006 issue was devoted to education and included articles discussing general needs for education in electrochemistry as well as some examples of approaches, and even specific laboratory activities, to enhance electrochemical education. More recently, in the summer 2010 issue, the ECS Industrial Electrochemistry and Electrochemical Engineering Division provided an additional evaluation of needs and some activities for introducing electrochemistry into courses. The current issue complements those earlier issues and provides insights on the status and needs in electrochemical education.

The first article provides a general backdrop on the state of higher education. Marye Ann Fox discusses the financial challenges being faced by academic institutions and how these challenges have an impact on the design and implementation of educational programs. The focus is narrowed to chemistry in the second article, in which Larry Faulkner discusses issues in graduate education in the chemical sciences that are being addressed by a presidential commission of the American Chemical Society. The third article further narrows the focus to the status of education in one important area of electrochemistry—corrosion. Wesley Harris and John Scully report on the findings of the National Research Council Committee on Assessment of Corrosion Education, which was tasked with evaluating the level and effectiveness of education in corrosion science. The committee identified ways in which government, industry, and academia should work toward improving the preparation of engineers for addressing the challenges associated with the corrosion of materials.

(continued on next page)

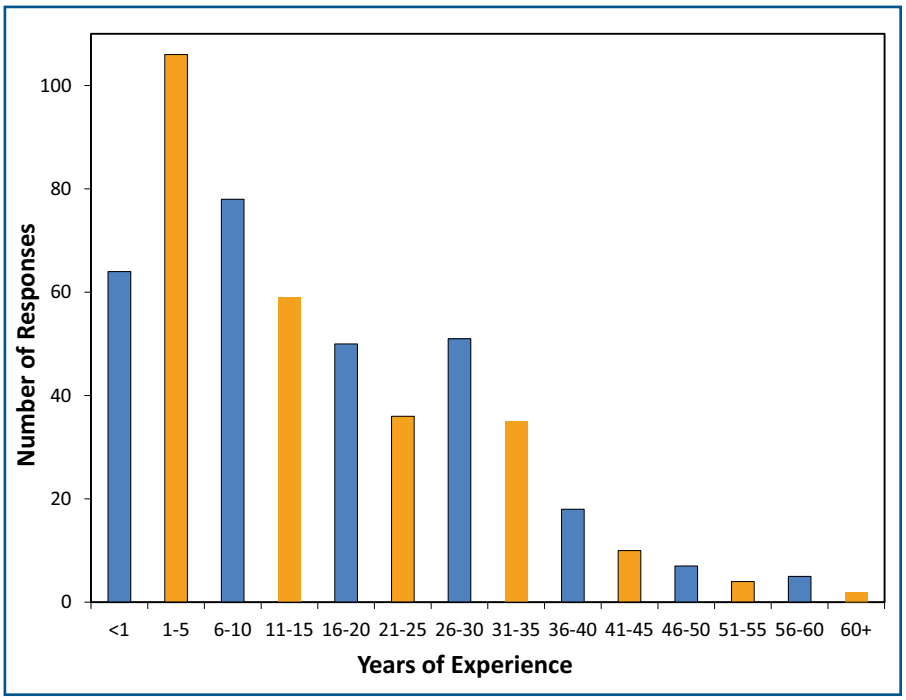

Fig. 1. *Professional experience of individuals responding to survey on electrochemical education (The Electrochemical Society, January 2012).*

(continued from previous page)

Effective education requires quality resources, one of which, textbooks, is the subject of the fourth article. Dan Scherson provides an assessment of the coverage of electrochemistry in the most popular physical chemistry textbooks. Based on this review, he provides suggestions for revisions and additional topics to not only address technological needs, but also to spark the interest of students and attract them to pursue careers in electrochemical science and technology.

Because electrochemistry is not typically identified as a separate academic discipline, the role of professional societies, like ECS, is particularly important. ECS provides educational programs, such as short courses and tutorials, to bridge the gap some individuals may face between their formal education and the information presented in technical publications and reports. In the fifth article, Durga Misra discusses such activities in the area of dielectric semiconductor materials, devices and processing.

While these articles may only scratch the surface of education in electrochemistry, they will hopefully provide some useful insights and generate interest in developing activities to expand the knowledge and improve the capabilities of individual scientists and engineers, so that they can more effectively address technical challenges in electrochemistry and solid-state science. ■

About the Author

Jeffrey W. Fergus is a member of the ECS Education Committee and Chair of the High Temperature Materials Division. After receiving his PhD from the University of Pennsylvania and a postdoctoral appointment at the University of Notre Dame, he joined the materials engineering faculty at Auburn University, where he is currently a professor. His research interests are in the high temperature and solid state chemistry of materials, including the chemical degradation of materials and materials for electrochemical devices, such as chemical sensors, batteries, and fuel cells. He may be reached at jwfergus@eng.auburn.edu.

You Say Potato, They Say Portable Energy Source

When life gives you lemons, make a battery! That seems to have been the motto of two young students from the Tollgate Grammar School Science Fair in Pennington, NJ (home to ECS's headquarters). The two students displayed their work this past February, which showed their experimentation with the electrical charges of various fruits and vegetables. We all remember making those potato batteries, but it's nice to see these students take that a step further – and maybe on their way to becoming future electrochemists!