UPD, SLRR, SEBALD: Abbreviations with Many Connotations

by Stanko R. Brankovic

Electrochemical deposition is a complex phenomenon that spans over different areas of chemistry and kinetics, thermodynamics, mechanics, metallurgy, and material science. It takes place at the solid/liquid and/or liquid/liquid interface, which makes the process somewhat unique and fascinating. Our knowledge in this area has significantly improved over the years, leading to the development of new methods and protocols with unprecedented levels of morphology control, composition, structure, and spatial resolution. Along these lines, in this issue of *Interface*, we focus our attention on several methods and phenomena that have attracted a growing interest in the past decades.

Underpotential deposition (UPD) is an enabling phenomenon that exploits the low energy of the metal ion precursors in solution to control the formation of single atomic layers via self-limiting processes. A monoatomic layer of metal is deposited on a conductive substrate at a potential more positive than the redox potential. UPD has been used to modify catalyst surfaces with metallic sub- or monolayers and as an analytical method to determine surface area. In some instances, UPD monolayers are used to enhance deposition kinetics, either serving as surfactants or as flux mediators. The successive deposition of atomic layers at underpotential forming a surface compound—also called electrochemical atomic layer deposition (EC-ALD)—has found wide application in the layer-by-layer growth of semiconductor superlattices.

Deposition via surface limited redox replacement (SLRR) of UPD monolayer involves UPD monolayer formation, followed by displacement of this layer with a full or partial monolayer of a more noble metal, through a cementation process (galvanic displacement). An analogous process, selective electrodesorption-based atomic layer deposition (SEBALD) consists of the formation of a sacrificial sulfur monolayer to induce UPD of late transition metals such as Fe, Co, and Ni in the form of monolayers or nanosized islands. Both processes are used extensively by practitioners in different areas to synthesize monolayer or nanocluster catalysts and ultrathin films with different compositions and applications.

The articles presented in the following text discuss the fundamentals and potential applications of these deposition methods. The journey starts with description of the fundamental relations between experimental conditions during SLRR of UPD monolayer and the resulting morphology of the deposit. The following article by Dimitrov et al. brings the example and a critical outlook to the thin film growth applications. As a second part of this story, the article by Vasiljevic delivers comprehensive insight into the SLRR of UPD monolayer for various catalyst synthesis applications. The final post in the journey is the article by Innocenti et al. showing an example of SEBALD for growth of high-quality Bi films.

As many researchers in this field have contributed greatly to the magnificent development of these methods, I am sure that interested practitioners can find many other articles in the literature with a wealth of information. Therefore, there is no doubt that new ideas and approaches involving SLRR and SEBALD are being researched, which leaves the guest editor of this issue with a strong impression that the best is yet to come.

 DOI: 10.1149/2.F04182if.

About the Guest Editor

Stanko R. Brankovic is a professor in the Department of Electrical and Computer Engineering and the Department of Chemical and Biomolecular Engineering at the University of Houston. His research is focused towards better understanding of the physical and chemical processes at the electrochemical interface and their use in producing materials and nanostructures with novel functionality and applications. The diverse and multidisciplinary nature of his research spans the areas of sensors, magnetic materials, thin films, electrocatalysis, and nanofabrication. He may be reached at SRBrankovic@uh.edu.