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ATOMIC LAYER DEPOSITION FOR EMERGING THIN-FILM MATERIALS AND APPLICATIONS

Introduction

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Atomic layer deposition (ALD) is a powerful and elegant technique for depositing atomically controllable thin film materials. ALD proceeds with a unique growth mechanism relying on alternately sequential surface-controlled self-saturation reactions, which enables the atomic-scale layer-by-layer deposition of the uniformly conformal films over virtually any topologies. Since the 2000s, ALD has greatly widened its variety of applications from semiconductors to catalysis, biomedicine, gas sensing, anti-corrosion coating, clean-energy technologies (batteries, fuel cells, supercapacitors, solar cells, etc.), and nano- and micro-electromechanical systems (N/MEMS). The characteristic merits of ALD include not only its superior controllability over film thickness, composition, and crystallinity, but also its unique capability for constructing conformal thin-film coatings on complex structures. These merits underlie the fast expansion of ALD into new areas over the past decades, such as metal-organic frameworks, two-dimensional layered materials, single-atom catalysis, solid-state batteries, and so forth. Along with these research developments, more efforts are urgently needed to develop ALD precursors for new processes and novel nanostructured materials for emerging applications in various areas. In addition, a good understanding of the related ALD mechanisms is also critical for advancing this technology.

In this Focus Issue, we have captured a portion of the broad research in ALD. This issue includes fundamental ALD research on surface chemistry (i.e., amidinate metal complexes) and thin film growth (i.e., ZrO_2, (Sn,Ca)S, $Fe_{1-x}C_x$, Al-doped ZnO). This issue comprises work on emerging applications of ALD, such as $Al_2O_3/ZnO/Al_2O_3$ stacked transistors, $Mg_xCa_{1-x}O$ wide-band-gap semiconductors, $NiS_x@MoS_2$ electrocatalysts, Na-Se batteries, and supercapacitors. Particularly, this issue features review articles introducing the ALD advances in nanostructured materials, organic light-emitting diodes display, high-k dielectric materials for capacitors, energy storage and sensing, and lithium-ion batteries. We hope that readers will find this volume to be compelling and these articles to be helpful for their research.

Finally, we are very grateful to both the authors and reviewers of the many high-quality manuscripts submitted to this *Journal of Materials Research* Focus Issue on Atomic Layer Deposition for Emerging Thin-Film Materials and Applications.

ON THE COVER

This image schematically illustrates the atomic-scale layer-by-layer deposition of a uniform conformal film on a trench structure by atomic layer deposition (ALD) (courtesy of Prof. Rong Chen's group at Huazhong University of Science and Technology).