IS-001 <Invited Talk>

Hybrid Organic–Inorganic Films Fabricated Using Atomic and Molecular Layer Deposition Techniques

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Atomic layer deposition (ALD) and molecular layer deposition (MLD) are based on sequential, self-limiting surface reactions that produce atomic layer controlled and conformal thin film growth. ALD can deposit inorganic films and MLD can deposit films containing organics. ALD and MLD can be used together to fabricate a wide range of hybrid organic-inorganic alloy films. The relative fraction of inorganic and organic constituents can be defined by controlling the ratio of the ALD and MLD reaction cycles used to grow the film. These hybrid films can be tuned to obtain desirable mechanical, electrical and optical properties. This talk will focus on the growth and properties of metal alkoxide films grown using metal precursors and various organic alcohols that are known as "metalcones". The talk will highlight the tunable mechanical properties of alucone alloys grown using Al_2O_3 ALD and alucone MLD and the tunable electrical conductivity of zincone alloys grown using ZnO ALD and zincone MLD with DEZ and hydroquinone as the reactants.

IS-002 <Invited Talk>

Active Materials for Energy Conversion and Storage Applications of ALD

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Atomic layer deposition (ALD), utilizing self-limiting surface reactions, could offer promising perspectives for future efficient energy conversion devices. The capabilities of ALD for surface/interface modification and construction of novel architectures with sub-nanometer precision and exceptional conformality over high aspect ratio make it more valuable than any other deposition methods in nanoscale science and technology. In the context, a variety of researches on fabrication of active materials for energy conversion applications by ALD are emerging. Among those materials, one-dimensional nanotubular titanium dioxide, providing not only high specific surface area but also efficient carrier transport pathway, is a class of the most intensively explored materials for energy conversion systems, such as photovoltaic cells and photo/electrochemical devices. The monodisperse, stoichiometric, anatase, TiO_2 nanotubes with smooth surface morphology and controlled wall thickness were fabricated via low-temperature template-directed ALD followed by subsequent annealing. The ALD-grown, anatase, TiO_2 nanotubes in alumina template show unusual crystal growth behavior which allows to form remarkably large grains along axial direction over certain wall thickness. We also fabricated dye-sensitized solar cells (DSCs) introducing our anatase TiO_2 nanotubes as photoanodes, and studied the effect of blocking layer, TiO_2 thin films formed by ALD, on overall device efficiency. The photon convertsion efficiency ~7% were measured for our TiO_2 nanotube-based DSCs with blocking layers, which is ~1% higher than ones without blocking layer. We also performed open circuit voltage decay measurement to estimate recombination rate in our cells, which is 3 times longer than conventional nanoparticulate photoanodes. The high efficiency of our ALD-grown, anatase, TiO_2 nanotube-based DSCs may be attributed to both enhanced charge transport property of our TiO_2 nanotubes photoanode and the suppression of recombination at the interface between transparent conducting electrode and iodine electrolytes by blocking layer.

Keywords: Atomic layer deposition, Dye-sensitized solar cells, titanum dioxide, Nanotube