ALD/MLD applications for Energy Storage and Conversion: from Nano Scale to Single Atoms

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Energy shortages and environmental pollution are two serious challenges that humanity will face in the long-term. Dr. Sun's research is applying nanotechnology such as atomic layer deposition (ALD) and molecular layer deposition (MLD) to address challenges in lithium ion batteries and low temperature fuel cells.

Over the past few years, advanced rechargeable batteries including lithium-ion batteries (LIBs), lithium-sulfur (Li-S) batteries, alkali metal-oxygen (Li-O_2, Na-O_2) batteries and all-solid-state batteries have attracted intensive research attention as one promising solution to solve the global energy and environment problems due to high energy density and long working life. Although remarkable development has been made on the rechargeable batteries, there are still some key challenges for the practical application in electronic vehicles (EVs) and large-scale energy storage. One of challenges is control of interfaces between electrolytes and anode/cathode electrodes in the above systems. ALD and MLD techniques [1] can address these challenges. Here, a few successful examples from our work will be given including lithium-sulfur (Li-S) batteries [2], alkali metal-oxygen (Li-O_2, Na-O_2) batteries [3-6] and all-solid-state batteries.

Fuel cells are electrochemical devices that can convert the chemical energy of a fuel directly to electrical power. However, there are still challenges ahead which are hindering the market implementation of PEMFC technology, mainly high cost of materials and the durability during fuel cell life-time operation. The high cost is primarily associated with precious metal catalysts (Pt or Pt alloys). We used ALD to control the size of Pt down to single Pt atom catalysts [7,9]. We will used area-selected ALD to prepare Pt-based high stable catalysts for fuel cells[10]. I will also discuss some future perspectives.

References:

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