Layer-by-layer Assembly of Very High Ionic Conductivity Polymer Electrolyte Material for Electrochemical Devices
Technology #12912

Applications

This technology can be used to construct electrochemical devices comprising of a solid polymer electrolyte as well as hydrogen and direct methanol fuel cells. These films can be used in electrochemical applications that require an ion-conducting material to operate. Improved electrochemical devices will be useful for companies focused on attaining sustainable energy sources as well as battery-manufacturing companies.

Problem Addressed

Electrochemical devices such as batteries, fuel cells, and dye-sensitized photovoltaic cells have potential to help with the world's energy crisis. However, solid state electrochemical devices often suffer from low ionic conductivity values of the polymer electrolyte component. This invention minimizes performance losses associated with low ionic mobility by creating polymer electrolytes in the form of thin films in order to facilitate the transport of a given ion and thus reduce the electrical resistance within the device.

Technology

This invention is a method to assemble a highly conducting, hydraulically stable polymer electrolyte film from commercially available, water-soluble polymers using layer-by-layer assembly technology. By using a range of multi-layer systems that incorporate hydrophilic polymers using electrostatic and hydrogen bonding mechanisms, Layer-by-layer technology assembly creates an explicit increase in ionic conductivity of three or four orders of magnitude. Additionally, layer-by-layer assembly allows the user to tune the thickness and permeability of the thin films by giving the choice of polyelectrolytes and adsorption conditions. This system also allows for high composition control through adjusting the initial assembly conditions, nanometer-level thickness accuracy, and highly adaptable aqueous processing conditions. Assembly conditions of these systems, such as pH and ionic strength, are adjusted to achieve the desired properties of resulting films. For example, using strong polyelectrolytes with hydrocarbon backbones yields LbL films that tend to be either strongly or moderately hydrophobic, thus discouraging proton exchange. In addition, these films can be deposited on low surface energy substrates, which can be easily removed to produce “free standing” films that can be directly used in electrochemical devices.

Advantages

- Capable of maximum ionic conductivity, over 300x higher than previously reported layer-by-layer films
- At least 100x lower methanol permeability values compared to current industry standard materials
Categories For This Invention:

- Energy
- Fuel Cells
- Materials
- Polymers (Materials)

Intellectual Property:

Highly conducting solid state ionics for electrochemical systems and methods of fabricating them using layer-by-layer technology
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Publications:

Highly Conductive, Methanol Resistant Polyelectrolyte Multilayers
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External Links:

The Hammond Lab
https://hammondlab.mit.edu/

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