Layered Nanotubes from Electrostatic Assembly

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Presentation

Short Description: **Two-dimensional and three-dimensional spatial control of materials functionality is critical for emerging applications such as energy storage, smart surfaces, and biomimetics. By combining electrostatic layer-by-layer assembly and nanotemplating, nanotubes containing multifunctional shells are demonstrated. A broad range of materials (inorganic nanoparticles, polyelectrolytes, polystyrene) can be layered within the templates to yield complex structures with two length scales of control: layer-level control (Angstroms to nanometers) and nanotube-level control (15 nm – 200 nm).**

Keywords: polyelectrolyte multilayers, anodic aluminum oxide, nanotemplating, assembly, electrostatic, nanotube, nanowire

Abstract: As the size of devices and systems becomes increasingly smaller, the need for high-performance, small-geometry materials increases. Scaling a material down to the nanoscale imparts new, and often synergistic, properties that excel relative to the bulk. This enables the creation of nanotechnologies such as micro- or nanobatteries and nano-fuel cells. For truly micro- to nanoscale devices to be realized, fine spatial control of materials placement and functionality is required. Using directed electrostatic assembly and nanotemplating, we demonstrate the hierarchical design of multifunctional layered nanotubes containing both inorganic and organic components.

Layer-by-layer (LbL) assembly is the aqueous-based alternate adsorption of oppositely charged species to a substrate.[1] LbL assembly is performed on an anodic aluminum oxide (AAO) template, where the layers coat the template's pore wall under carefully selected processing conditions.[2] Templates created in-house using a two-step anodization process[3] produce nanotubes having diameters ranging from 15 to 100 nm and lengths from 200 nanometers to 100 micrometers. The combination of these two techniques represents two levels of spatial control. The layer-by-layer assembly technique allows for tuning of layer thickness (Angstroms to nanometers) and spatial placement via sequential deposition, and nanotemplating allows for control of geometric complexity via nanotube diameter and length.

Future work will investigate the electrochemical activity of the LbL-nanotubes relative to bulk LbL films. We hypothesize that the reaction-diffusion properties of the nanostructured tubes will surpass those of the bulk film. We envision this breakthrough to emulate structures required for the creation of nanotechnologies such as nanobatteries and nano-fuel cells.

References

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