Artificial films mimic myelin sheath in new research

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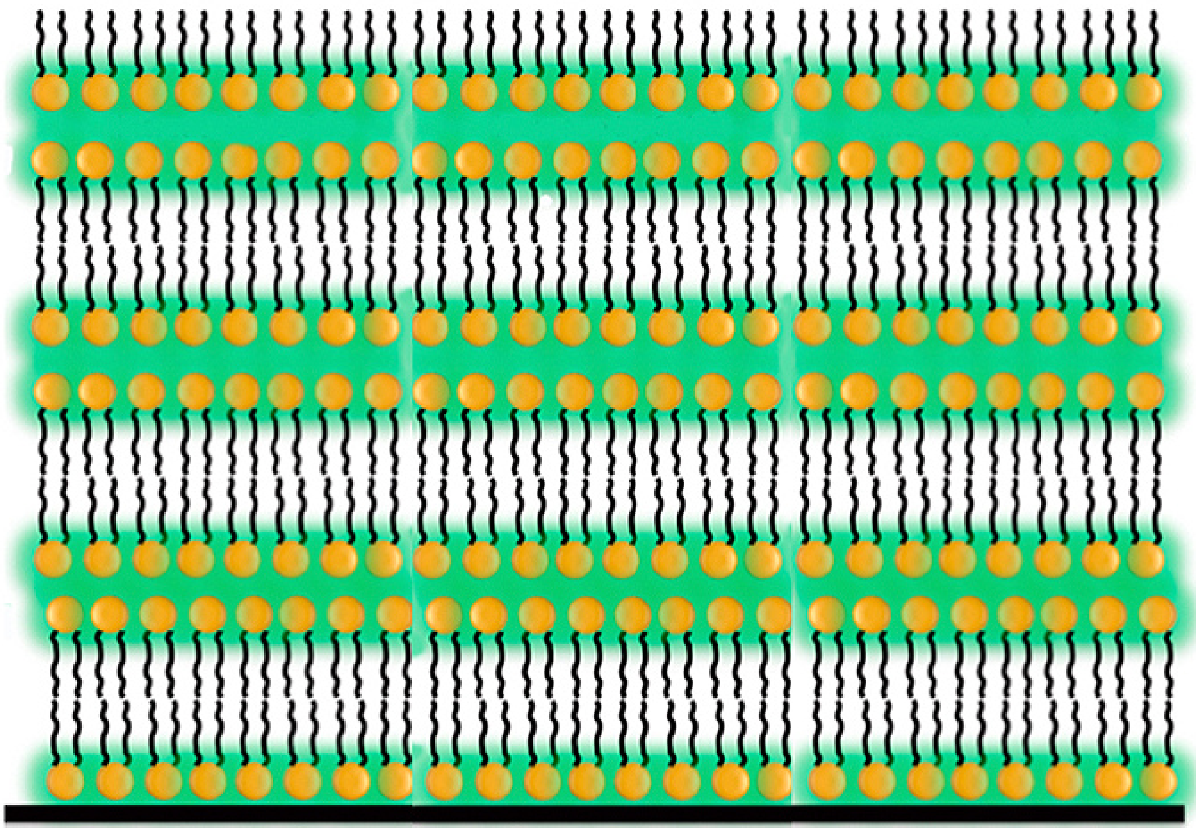

Los Alamos researchers and collaborators recently synthesized and characterized highly ordered and stable phospholipid-silica thin films that resemble the multilayer architectures present in nature, such as the myelin sheath that surrounds the axon of a neuron. Phospholipids are the primary building blocks of biological membranes that provide barriers to compartmentalize cells and their components. These membranes are dynamic and fluid in nature, incorporating proteins that perform critical functions including solute transport, signal transduction, and ATP synthesis. Phospholipid-based synthetic nanomaterials have potential applications, including drug delivery, sensing, energy harvesting, and as model systems in basic research. However, their fragility, instability in air and air-water interfaces and lack of long-term stability in aqueous solution limit their utility.

Significance of the research

The journal ACS Nano published the research team's findings, and this is the first report of a hybrid and highly ordered phospholipid-based multilayer assembly that maintains its structure and fluid functionality upon incorporation into a synthetic inorganic matrix. The technique lays a foundation for future applications of artificial membranes in a variety of potential applications including biosensing, proton transport membrane, separations, high throughput drug discovery, and biophysical/biochemical studies.

Research achievements

This process is simple and scalable. The scientists spin-coated phospholipids onto a silicon wafer substrate. Then the team used a near room temperature method to expose the highly ordered lipid films to vapors of silica precursor and water, resulting in the formation of nanostructured hybrid assemblies. Silica forms selectively between the lipid head groups of the layered lipid assemblies. The team precisely controlled the synthesis conditions to achieve either multilayer or hexagonally ordered structures, with thicknesses from 10 to 200 nm.

The films exhibit long-term structural stability in air and when placed in aqueous solutions, and they maintain their fluidity under aqueous or humid conditions. This platform provides a model for robust implementation of phospholipid multilayers and a means toward future applications of functional phospholipid supramolecular assemblies in device integration.

The research team

The Los Alamos team includes Gautam Gupta of the Center for Integrated Nanotechnologies, Srinivas Iyer and Kara Leasure of Bioenergy and Biome Sciences, and Andrew M. Dattelbaum of Materials Synthesis and Integrated Devices. Coauthors are Nicole Virdone and Gabriel P. Lopez of Duke University and Plamen B. Atanassov of the University of New Mexico.

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Caption for image below: Schematic of the vapor phase introduction of silica. Water vapor and silica condense on the lipid head group regions of the spin-coated lipid layers.