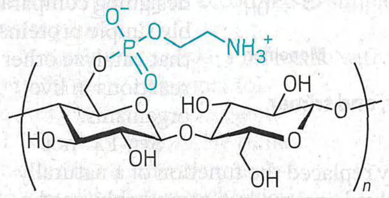
BIOLOGICAL CHEMISTRY

Bacteria make modified cellulose

Cellulose is an abundant biopolymer made of strands of β-1,4-linked glucose units. It provides mechanical strength to plants and biofilms made by bacteria. A team led by Lynette Cegelski of Stanford University and Regine Hengge of Humboldt University of Berlin now reports that the cellulose made by bacteria is a chemically modified version (*Science* 2018, DOI: 10.1126/science.aao4096). Using solid-state nuclear magnetic resonance spectroscopy to analyze the structure of the cellulosic material, the researchers determined that it contains a phosphoethanolamine group (shown in blue) attached to the C6 position of



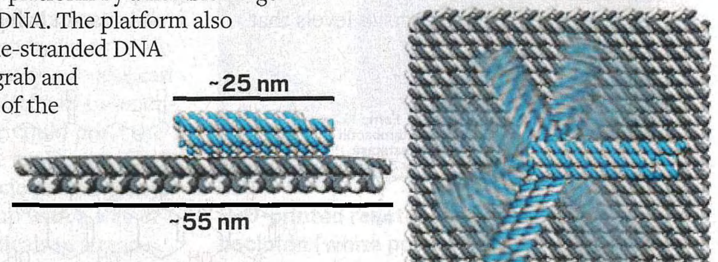
Phosphoethanolamine cellulose repeating unit

a glucose ring in the repeating unit. The modification had not been observed before because standard HCl hydrolysis degrades the modification, leaving only glucose, glucose-6-phosphate, and ethanolamine. The researchers also identified the genes behind the modification. They propose that a protein known as BcsG acts as an enzyme that installs phosphoethanolamine and that two other proteins in the same cluster play roles. By making mutant bacteria that can't make phosphoethanolamine-modified cellulose, the researchers find that the modified cellulose is necessary for *Escherichia coli* bacteria to form biofilms with the correct architecture. The team hopes to use the biosynthetic machinery to make bioengineered cellulosic materials with other types of modifications.—CELIA ARNAUD

NANOMATERIALS

Robot arm carries nanoscale cargo

Taking a step toward a nanoproduction line of the future, researchers in Germany have developed a DNA "robot arm" that can move cargo from one point to another (*Science* 2018, DOI: 10.1126/science.aan4284). The system relies on DNA origami structures, built from strands of DNA that self-assemble into predetermined shapes. The team created a 55-nm-wide DNA origami platform and a sturdy 25-nm-long bundle of DNA helices to form an arm. One end of the arm attaches to the platform by a flexible hinge of single-stranded DNA. The platform also sports several single-stranded DNA "latches" that can grab and hold the other end of the arm as it swings around. The team then loaded the robot arm with a gold nanorod as cargo. DNA is a highly charged molecule, so the researchers manipulated the arm by varying the voltage between four electrodes placed around the DNA device. This gave them macroscopic control over nanoscale movements, enabling them to unlatch, move, and relatch the arm in a different position, along with its cargo. The process is much faster than other DNA-based cargo carriers, such as DNA walkers, which can take hours to traverse similar nanometer distances. "We can switch this in milliseconds," says Friedrich C. Simmel of Technical University of Munich, part of the team behind the work. The group is now trying to modify the arm to enable it to pick up and deposit the cargo.—MARK PEPLOW, special to C&EN

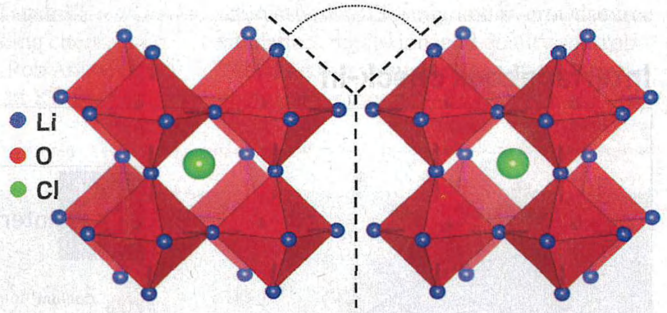


The arm of a DNA robot spins on a platform.

ENERGY STORAGE

Grain boundaries impede ion conduction in solid-state Li-ion batteries

Rechargeable lithium-ion batteries power many of today's electric vehicles and nearly all portable electronic gadgets and power tools. These devices boast extreme reliability, but they depend on a flammable liquid organic electrolyte solution to shuttle ions between the electrodes, and those liquids pose a tiny but potentially serious fire hazard. So researchers have been searching for nonflammable solid electrolytes as replacements. Although some are nearing commercialization, scientists still do not know some basics, for example, how grain boundaries—interfaces between crystallites of the electrolyte—affect lithium-ion conduction, which controls battery current. So James A. Dawson and M. Saiful Islam of the University of Bath and coworkers carried out molecular dynamics simulations to study how readily lithium ions can hop across grain boundaries in polycrystalline Li_3OCl, a promising solid electrolyte candidate. The team stresses that grain boundaries may enhance or impede ion conduction: The effect cannot be determined a priori. It turns out they don't help matters in Li_3OCl. Crystal interfaces lower ion conductivity by about a factor of 10 (*J. Am. Chem. Soc.* 2018 DOI: 10.1021/jacs.7b10593). The team used the results to develop a model that quantifies the effect of grain boundaries on conductivity as a function of crystallite size and suggests how tailoring the microstructure can optimize the performance of a variety of solid electrolyte materials.—MITCH JACOBY



The interface, or grain boundary (dashed line), between uniquely oriented crystallites of Li_3OCl, a solid electrolyte (dotted line indicates tilt angle between grains), impedes Li-ion conduction.

CREDIT: *SCIENCE* (DNA); *J. AM. CHEM. SOC.* (INTERFACE DIAGRAM)