JOURNAL OF THE AMERICAN CHEMICAL SOCIETY

Spotlights

pubs.acs.org/JACS

Spotlights on Recent *JACS* Publications

TINY STRUCTURES MAKE COMPETITION VISIBLE

Nanostructures are the visual result of atomic competition. To build a nanomaterial from the bottom up, the researcher must create an environment such that the target structure is the naturally occurring product under the given conditions. Each structure is a final score in a battle between opposing forces. So when researchers discover an unusual nanostructure, they uncover not only a new building block but also a new source to infer atomic interactions.

Yihan Zhu, Hongyu Chen, Yu Han, and other researchers observe a unique helix shape in a thin nanowire of pure gold atoms (DOI: 10.1021/ja506554j). Shaped like a twisting tetrahedron snake, the structure is intriguing because such chiral metallic nanocrystals are rare. With careful microscopic study and theoretical simulations, the researchers show that the unusual structure may result from competition between forces that seek to create the most stable internal structure, and those that seek to minimize the surface energy, i.e., to minimize the number of surface atoms and to maximize their interaction with the surface molecules or ligands.

The twisting structures form only in the thinnest of the gold nanowires. As nanowires grow thicker, the influence of surface energy diminishes, and these unique helices no longer form. Chiral metallic crystals such as these can also be of practical use in chemical separation, sensing, and catalysis.

Jenny Morber, Ph.D.

CAGED DYES MAKE ACIDITY SPIES

A cell's acidity, or pH, plays an essential role determining how the cell moves, works, reproduces, and dies. Litmus paper is the acidity test of science kits and chemistry classrooms, but it cannot fit inside a cell, so researchers have developed several alternate strategies to probe cellular pH. Techniques that exploit pH-reactive fluorescent dyes can be especially useful because they are very sensitive and can rapidly pinpoint measurements in specific areas. Unfortunately, live cells often "spit" the dyes out, and the molecules tend to clump together, reducing the visual signal.

Wenbin Lin and colleagues have created longer-lasting sensors using metal–organic frameworks to trap pH-sensitive fluorescent dyes (DOI: 10.1021/ja507333c). These probes retain the benefits of fluorescent pH sensors without dye leaching and clumping. In experiments, the cage-based sensors are taken up by cells, maintain their structural integrity, remain longer than traditional fluorescent probes, and provide rapid and precise pH measurements. The probes also provide the researchers with new information about how acidity changes as cells absorb and transport foreign objects. With such reliable real-time pH sensors, researchers should be able to more easily and accurately probe the interplay between acidity and cellular behavior.

Jenny Morber, Ph.D.

A CHEAPER WAY TO STORE AND RELEASE HYDROGEN'S ENERGY

Taking advantage of the abundant energy in hydrogen for practical applications requires its storage at high pressures, low temperatures or in expensive metal hydrides, or the decomposition of hydrogen-containing liquids such as ammonia using expensive catalysts. As early as 1894, a young researcher in the United Kingdom observed a cheap alternative catalyst: sodium amide. Now a team, led by Bill David, has performed a series of simple demonstrations with sodium amide in a flow reactor to convert over 99% of ammonia gas into its constituents, nitrogen and hydrogen (DOI: 10.1021/ja5042836).

Sodium amide has a low melting point and high reactivity, the researchers point out, which may explain why scientists have neglected closer study of this reaction before. Ammonia, which could serve as a way to transport and store hydrogen, is also toxic. Yet when the team experiments at low pressure with various temperature and surface area configurations, they show that sodium amide competes with much costlier conventional catalysts based on ruthenium and nickel. Such a reaction could help drive future development of lower cost ammonia- or hydrogen-powered vehicles.

Lucas Laursen

ENZYMATIC EXPLOITATION FOR GLYCAN EXPLORATION

Xiaotao Duan, Wen Yi, and co-workers report a new method to detect the Thomsen–Friedenreich (TF) antigen, a galactose-containing disaccharide broadly implicated in the development and progression of numerous human cancers (DOI: 10.1021/ja5054225). Effective detection of TF facilitates investigation into the complex biology of this tumor antigen, potentially leading to new strategies for cancer diagnosis and treatment.

TF is linked to serine or threonine residues of some proteins that reside on the surface of cancer cells. To detect TF among the jungle of other complex and diverse cell surface glycoprotein structures, the authors cleverly manipulate the activity of two bacterial enzymes. These highly specific enzymes transform cell-surface TF from a disaccharide to a tetrasaccharide that contains a built-in chemical tag, enabling subsequent detection with fluorescent or affinity probes. The researchers can use this method to detect TF antigens in protein samples as well as in cell lysates and live cells.

In addition to its use in TF biology, this approach can be applied to the study of other glycans with intriguing but poorly understood functions and is therefore a valuable addition to the notoriously sparse toolkit for the exploration of glycan biology.

Eva J. Gordon, Ph.D.

Published: September 9, 2014