JACS
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY
Spotlights
pubs.acs.org/JACS

Spotlights on Recent *JACS* Publications

CONNECTING THE MISSING LINK IN THE RADIALENE FAMILY

Radialenes are cyclic star-shaped hydrocarbons consisting only of sp^2-hybridized carbon atoms, where methylene groups branch out from central rings. Radialenes containing 3-, 4-, and 6-membered carbocycles were first prepared in the 1960s, but [5]radialene has eluded synthesis because the commonly used high-temperature elimination or rearrangement is of no avail.

To overcome this challenge, Michael Paddon-Row, Michael Sherburn, and co-workers have theoretically assessed the reactivity of [5]radialene, based on which they devise a successful preparative approach (DOI: 10.1021/jacs.5b07445). The researchers obtain [5]radialene by low-temperature decomplexation of its bis-$Fe(CO)_3$ stabilized adduct, as calculations suggest that the compound is significantly more susceptible to dimerization/polymerization than its homologues.

This work is a quintessential illustration of the utility and potential of theoretical computation-assisted rational design in organic synthesis. While advancing the overall understanding of radialene chemistry, it further reveals the structure−property relationship in this family of compounds, paving the way for concise access to complex structures in natural product synthesis, among other applications.

Xin Su, Ph.D.

BATTERY COMPONENT HELPS GREEN ENERGY GO WITH THE FLOW

Increasing global demands for electrical energy have motivated efforts to integrate renewable sources into the energy grid on a large scale. Unfortunately, the intermittent nature of energy sources like solar and wind currently limits their use because stops and starts are hard on many energy storage systems. Variable inputs are not a problem for redox flow batteries, which do not quickly discharge energy; however, current flow batteries suffer from relatively low power capability and high cost.

Melanie Sanford and her team present a redox flow battery component—an anolyte—that is soluble in nonaqueous solvents at all charge states, can be made from commercial materials in a single step, is stable, and meets cost and weight targets (DOI: 10.1021/jacs.5b09572). This small organic molecule is compatible with lithium ion electrolytes, facilitating coupling with other lithium-ion half-cells. The anolyte undergoes two reversible redox reactions in the presence of lithium electrolytes at low potentials. To find this diamond in the rough, the researchers used an iterative screening process, enabling a rapid scan of a large chemical space.

Improved cost and performance of redox flow batteries are necessary to make them realistic candidates for industrial-scale energy storage. The advance reported here moves us closer to a renewables-based energy future.

Jenny Morber, Ph.D.

NEW CATALYSTS FROM THE MARRIAGE OF CHEMISTRY AND BIOLOGY

Synthetic chemists continually seek new catalysts to speed up reactions. As part of this search, researchers have modified natural enzymes through directed evolution to carry out nonbiological reactions. Especially promising in this regard are enzymes that rely on cofactors for their activity; an enzyme−cofactor ensemble often has greater catalytic versatility than the enzyme or cofactor alone.

In this Perspective, Christopher Prier and Frances Arnold describe functional similarities between certain small-molecule catalysts, which are designed to carry out specific synthetic reactions, and natural cofactor-dependent enzymes (DOI: 10.1021/jacs.5b09348). They explore the potential of exploiting this understanding—in an approach they call chemomimetic biology—to create enzymes that catalyze reactions not known in nature.

For example, some enzymes that use the cofactor thiamine carry out acyl anion chemistry similar to that of certain N-heterocyclic carbenes. Through directed enzyme evolution that is informed by knowledge of the small-molecule organic catalysts, chemists can repurpose the cofactor-dependent enzymes to carry out reactions that are challenging for their synthetic brethren. The authors note that this area is ripe for exploration and could lead to exciting new catalytic capabilities.

Deirdre Lockwood, Ph.D.

ALKYLATION TO PROMOTE MUTATION

Seongmin Lee and co-workers report that alkylation of a specific site in DNA, N7-guanine, alters DNA structure in a manner that abets the generation of mutations and cross-links (DOI: 10.1021/jacs.5b10172). These findings offer clues into how common alkylating agents, such as nitrogen mustards, promote DNA sequence mutations, alterations that paradoxically can either drive or halt the growth of cancer cells.

The authors use a methylated guanine derivative and a novel host−guest complex system to probe how alkylation at N7, the most nucleophilic atom within DNA, affects DNA structure. They solve the crystal structures of DNA containing the methylated guanine paired with each of the four native DNA nucleosides to delineate the hydrogen bonding patterns in the alkylated structures. They determine that alkylation may stabilize the interaction between guanine and thymine or adenine, shifting the normal base-pairing pattern of guanine and promoting mutations in DNA sequence.

Understanding the mechanisms by which mutagens and anticancer agents transform DNA structure and affect cancer cell growth is imperative for the continued development of novel and effective therapeutics. The findings reported here inform continued efforts to manipulate cell division using DNA-altering agents.

Eva J. Gordon, Ph.D.

Published: November 16, 2015

ACS Publications © 2015 American Chemical Society

DOI: 10.1021/jacs.5b11912
J. Am. Chem. Soc. 2015, 137, 14547−14547