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YEAR IN CHEMISTRY

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In brief

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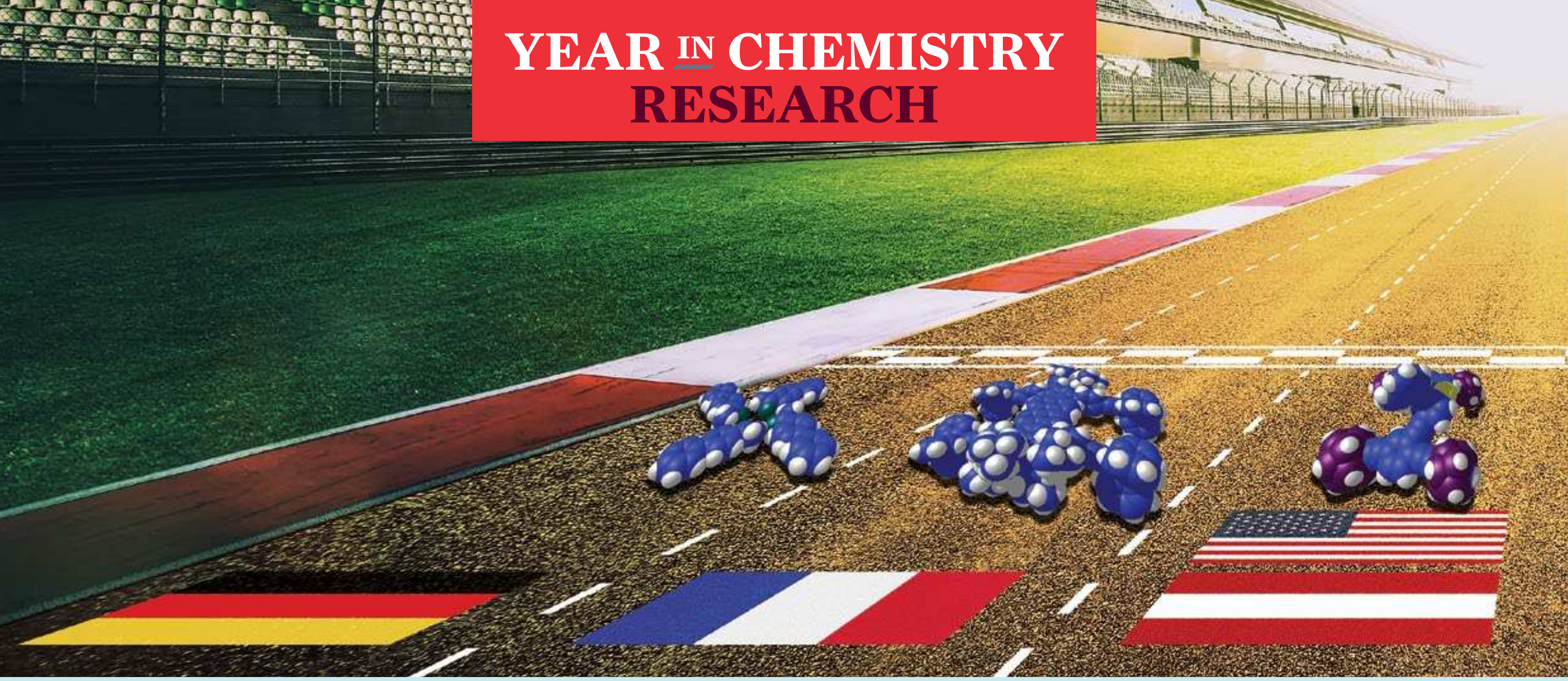


MOLECULAR MACHINES

BIG MOVES FOR LITTLE DEVICES

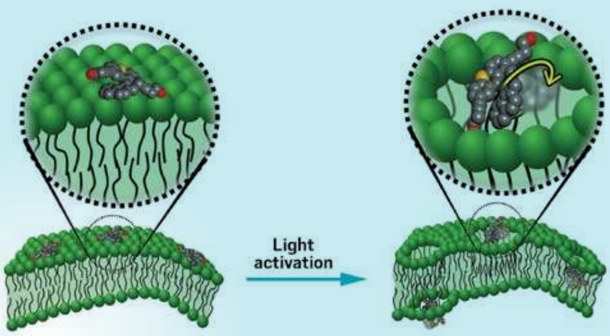
Geared up after last year's Nobel nod, researchers put rotors, drills, pulleys, and more into action

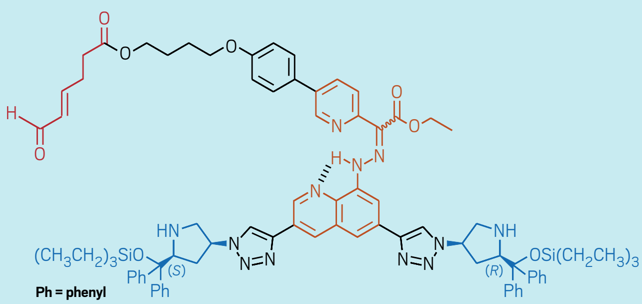
Since the 1980s, chemists have been creating molecular machines—single molecules that resemble and function like motors, rotors, and even tiny cars. When three molecular machine pioneers won the 2016 Nobel Prize in Chemistry, the field gained a certain gravitas: The whirligig molecules being created were certified as more than mere chemical curiosities. It's not a surprise that molecular machines continued to make headlines this year, including a souped-up motor-rotor combo, polymer pulleys designed to boost battery performance, and the world's first nanocar race.

"It is fascinating to see the current acceleration in the field," says Ben L. Feringa, one of the 2016 Nobel laureates. "The recent ingenious designs, ranging from molecular pumps to reshaping polymers, reflect how molecular machines will bring responsive and adaptive behavior, enabling numerous potential applications." Here C&EN revisits some favorite molecular machine stories of 2017.—BETHANY HALFORD

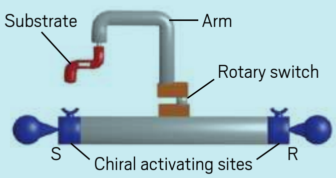
Drilling holes in cells

Scientists led by Rice University's James M. Tour turned ultraviolet light-activated molecular motors into tiny drills that can bore through cellular membranes. The idea is to get enough motors drilling into cancer cells in order to destroy the cells' integrity in a matter of minutes. Cancer cells can't develop a resistance to the molecular motor's motion the way they do for many chemotherapy treatments, Tour says (*Nature* 2017, DOI: 10.1038/nature23657).



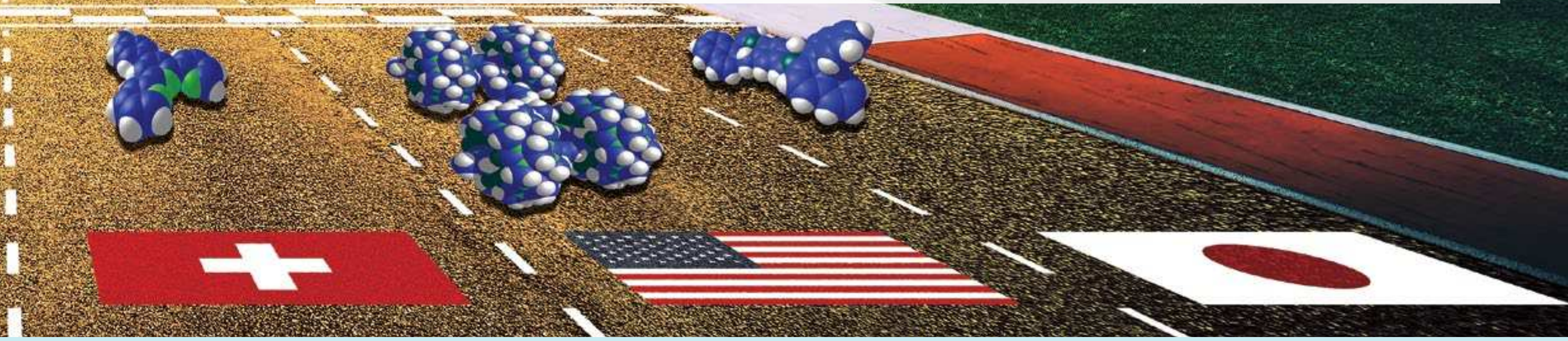


Chiral construction by molecular machines



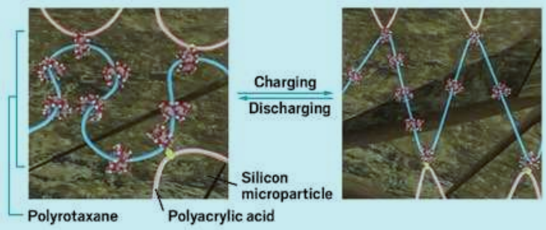
David A. Leigh and coworkers at the University of Manchester built a programmable molecular machine that creates four different products by adding thiol and alkene substituents asymmetrically to an α,β-unsaturated aldehyde substrate. The machine features an arm and rotatory switch that moves between a site for R stereochemistry and a site for S stereochemistry depending on pH (*Nature* 2017, DOI: 10.1038/nature23677).

CREDIT: TOUR GROUP/RICE UNIVERSITY (DRILL); *NATURE* (MACHINE ARM)



Nanocars zoomed into action

Move over, NASCAR. Nanocars have taken to the racing stage. Actually, real race car drivers probably won't need to move at all, because these little racers are measured in nanometers, and their racetracks have to be viewed with scanning tunneling microscopes. In April, six international teams participated in the world's first nanocar race, which resulted in a tie. Top honors went to the Nanoprix Team, led by Rice University's James M. Tour and the University of Graz's Leonhard Grill. Their Dipolar Racer featured low-adhesion molecular wheels, alkynyl axles, an aryl chassis, and dipolar functionalities in the nanocar's front and rear. Top honors also went to the makers of the Swiss Nano Dragster, a triangular molecule designed to glide and helmed by the University of Basel's Rémy Pawlak and Ernst Meyer.

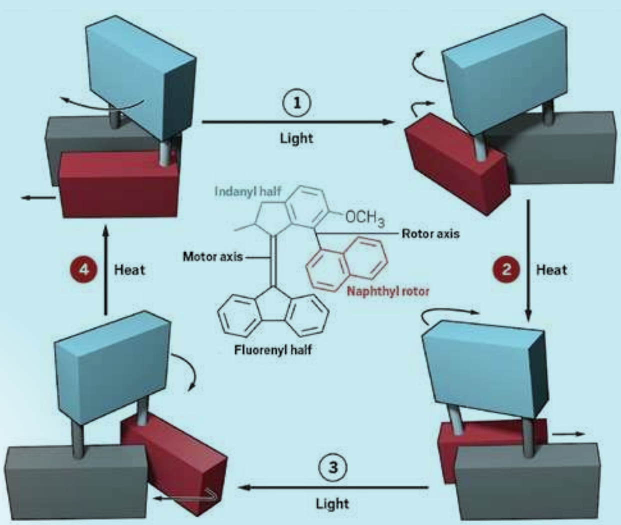


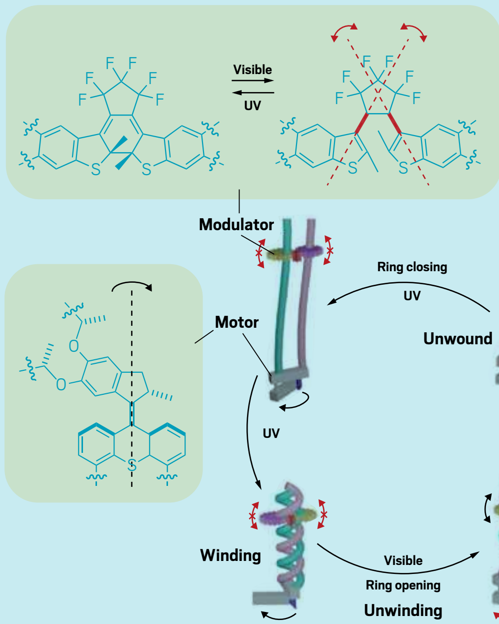
Polymer 'pulleys' for boosting battery performance

Researchers led by Ali Coskun and Jang Wook Choi at Korea Advanced Institute of Science & Technology developed polymers that, when added to a silicon anode, can relieve the stress the anode undergoes when charging and discharging so that it will last longer. The secret to the polymer's success: a network made of the linear polymer polyacrylic acid covalently linked to polyrotaxanes containing mechanical bonds. During battery charging, as the silicon anode expands, the polyrotaxanes' rings freely slide along the chain to dissipate stress, operating like a pulley system (*Science* 2017, DOI: 10.1126/science.aal4373).

Motor-rotor combo on the move

The University of Groningen's Ben L. Feringa upped the complexity of the classic light-activated molecular motor his group is known for by attaching a rotor to it. The two components turn with synchronized movement thanks to the assembly's complex stereochemical design (*Science* 2017, DOI: 10.1126/science.aam8808).





Winding and unwinding

By combining two types of light-activated molecular machines, a team led by the University of Strasbourg's Nicolas Giuseppone created a twisting system that winds and unwinds polymer chains, resulting in a material that contracts and expands depending on the wavelength of light shining on it. The system could lead to new types of actuators—for example, in artificial muscles (*Nat. Nanotechnol.* 2017, DOI: 10.1038/nnano.2017.28).

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