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Spotlights

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Spotlights on Recent *JACS* Publications

LIKE TINY DUCT TAPE, LITTLE SPHERES BRING TOGETHER UNLIKELY MATERIALS

Duct tape can do almost anything—repair a shelter, hem your pants, or make a pouch to hold your money—and its almost limitless utility lies in its ability to join things together quickly and easily. Researchers Sota Sato, Kiyotaka Shiba, Makoto Fujita, and colleagues have created a kind of molecular duct tape, which binds two entities that normally are not very compatible with each other: biomolecules and stable inorganic surfaces (DOI: 10.1021/jacs.5b06184).

Here, the "tape" is actually an organometallic sphere with two different attachments. One functional group latches onto inorganic surfaces, in this case the material titania, TiO_2. The other attachment is biotin, well known for its affinity to the protein streptavidin. The modified sphere becomes a linker, holding fast to the inorganic surface with one functional group, and grabbing onto proteins with the other.

Adhesion of biomolecules to inorganic surfaces is a fundamental need in biotechnology and medicine. Sensors tipped with biomolecules can detect and quantify virus antigens for disease detection, or complementary DNA for genetic tests. Researchers also seek to mimic nature's biominerals, which combine organic and inorganic materials to form hybrids that are both strong and light. This technique represents a design strategy to join molecular biology with inorganic surface chemistry.

Jenny Morber, Ph.D.

NEW METHOD TAGS RNA WITH A VARIETY OF FUNCTIONAL MOLECULES

RNA plays many critical roles in biology, including protein synthesis, gene regulation, and catalysis. Researchers must be able to detect and manipulate this class of nucleic acid in order to expand our understanding of RNA's numerous functions. Enzymes can be used to modify RNA; however, to date most modifications have involved indirectly attaching small molecules to RNA through bioorthogonal ligations. To make RNA tagging more sophisticated and useful, researchers want to directly attach larger affinity groups and fluorophores.

Now Neal Devaraj and his co-workers describe a way to directly modify RNA with a variety of large functional molecules (DOI: 10.1021/jacs.5b07286). RNA-TAG, where "TAG" stands for "transglycosylation at guanosine", uses a bacterial enzyme to incorporate a diverse set of functionalized probes into RNA. The enzyme replaces a key guanosine with a functionalized nucleobase within a short recognition sequence. Devaraj and colleagues use RNA-TAG to link the fluorophores BODIPY and Cy7 and the affinity tag biotin. Additionally they demonstrate fluorogenic labeling through incorporation of the intercalating probe thiazole orange.

The researchers selectively extract RNA molecules labeled with biotin from a complex mixture, and image messenger RNA inside cultured mammalian cells. They believe RNA-TAG will be an important method for facile modification and manipulation of endogenously transcribed RNA.

Rajendrani Mukhopadhyay, Ph.D.

NANOPOROUS MEMBRANES TACKLE THE TOUGHEST SEPARATIONS

The processing of natural gas yields a byproduct composed of a mixture of hydrocarbons, including propylene, a commodity chemical in high demand. A challenge in isolating propylene from this mix is separation from propane, another three-carbon molecule. One common approach uses an energy-intensive technique known as cryogenic distillation. Hae-Kwon Jeong and co-workers set out to develop materials that enable more energy-efficient separations, and they now report a new polymeric material based on a zeolitic imidazolate framework (ZIF), which has a nanoporous framework that can separate mixtures of propylene and propane with unprecedented performance (DOI: 10.1021/jacs.5b06730).

Previous research had shown that the 4-Å-sized pores in a membrane made from a ZIF material are ideal for achieving propylene/propane separation based on size differences. But the team finds that creating a high-performing ZIF membrane requires a well-defined film microstructure that can only be obtained when processing conditions are just right. A technique known as heteroepitaxial growth does the trick, enabling them to achieve a separation factor of roughly 200—which they say is a promising step in the direction of commercial applications.

Christine Herman, Ph.D.

METHANE STORAGE JUST GOT EASIER

Methane, a simple molecule with the chemical formula CH_4, is the primary component of natural gas. It is flammable and abundant, and it burns (relatively) clean, but methane currently supplies very little of the world's energy needs. One obstacle is that a much larger volume of methane is needed to produce the same amount of energy as, say, gasoline. Second, methane is difficult to store and transport because it is a gas at ambient conditions.

Researchers have been working to stabilize methane, and one promising strategy is to encase the molecule inside a porous host. Metal−organic frameworks (MOFs)—caged scaffolds composed of metal joints and organic linkers—present a promising solution. Unfortunately, the extreme conditions required by current strategies drive up costs.

Now, Mohamed Eddaoudi and colleagues create a MOF that efficiently stores methane at room temperature and reasonable pressures (DOI: 10.1021/jacs.5b07053). In experiments, the aluminum-based MOF demonstrates excellent carbon dioxide and oxygen uptake, greater than that of previously reported MOFs. Methane storage density is also high, meeting challenging energy targets. This study emphasizes that obstacles to cost-effective methane storage and transport are surmountable, and suggests that mobile methane storage is forthcoming with assistance from MOF technologies.

Jenny Morber, Ph.D.

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