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Spotlights on Recent *JACS* Publications

SWELL CONTROL OF MICROSPHERE PORES

Yonghui Deng and colleagues report the synthesis of magnetic mesoporous silica microspheres with large and tunable pores (DOI: 10.1021/jacs.5b05619). Such core–shell particles are useful tools for enzyme immobilization, drug delivery, and more. A magnetic iron oxide core assists manipulation and separation from solution, while the holey silica exterior can capture target molecules.

Previous magnetic mesoporous silica particles have been plagued by pores that are too small or of low quality. Here, micelles attach to the magnetic core like pool noodles on a beach ball, acting as spacers when silica backfill becomes the outer shell. When the micelle "noodles" are removed, the spaces they leave behind become the particle's pores. In this solution-based process, the faster the mixture is stirred, the more hexane solvent adsorbs into the micelle center, causing it to swell. Because each micelle "noodle" becomes a pore, this technique grants control over pore size simply by modulating the stir speed.

Experiments demonstrate that the resulting particles have high-quality pores and can efficiently capture the bioenzyme trypsin. Only small proteins are allowed to enter the pores and be digested by trypsin, achieving efficient size-selective proteolysis in a mixed protein solution. This simple and straightforward technique should readily transfer to other nanoparticle systems.
Jenny Morber, Ph.D.

BEYOND GRAPHENE: 2-D MATERIALS ARE JUST GETTING STARTED

In this Perspective, Hua Zhang and Chaoling Tan discuss the present and future of research related to epitaxial growth of nanostructures on ultrathin surfaces that are no more than a few atoms thick (DOI: 10.1021/jacs.5b03590). Epitaxial growth is the deposition of a material on the crystal face of another, with connections that align in the same structural orientation.

Researchers have long used single-crystalline surfaces to control growth of their sprouting nanostructures, but according to Zhang and Tan, ultrathin nanosheets confer additional benefits. Some ultrathin two-dimensional sheets are solution friendly, allowing high-yield and large-scale growth of multi-component hetero-nanostructures in large liquid batches. For electronics, ultrathin nanosheets can assist the ongoing push toward miniaturization. Beyond the size advantages, these ultrathin nanosheets afford high-quality and controlled placement of electronic junctions. Interactions between the nanosheet and other components—more pronounced at reduced dimensions—can improve optical and electronic properties. High surface area nanosheets promote efficient charge transfer and ionic interchange at catalyst surfaces, too.

The authors acknowledge that the field is yet in its infancy and look forward to future explorations of single-layer metal–organic frameworks and organic crystals, design of mixed-component noble metal catalysts, and new insights into the formation and epitaxial growth of nanostructures on these thinnest of substrates.
Jenny Morber, Ph.D.

IMPROVED CHARACTERIZATION OF NANOMATERIAL MORPHOLOGY

The morphology—or geometric shape and dimensions—of a nanomaterial can be important in defining the material's properties. Conventional microscopy methods may be insufficient to characterize the morphology of nanoparticles, especially when the nanoscopic structures agglomerate. Now, Clare Grey and colleagues present a comprehensive morphology analysis of nanoparticles of TiO_2 (B), a polymorph of titania that has received considerable recent interest as a promising lithium-ion battery anode material (DOI: 10.1021/jacs.5b08434).

Structure modeling is combined with X-ray powder diffraction (XRPD), pair distribution function (PDF), and small-angle X-ray scattering techniques. TiO_2 (B) nanoparticles with various shapes are constructed based on parameters obtained from these measurements. In parallel, XRPD and PDF patterns are simulated from resulting structural models and then compared to experimental data to determine the best-fitting model.

The authors conclude that the morphology of average TiO_2 (B) nanoparticles is an oblate ellipsoid contracted along the *b*-axis. This work provides a novel way to characterize the morphology of nanomaterials as the foundation to link shape with performance in specific applications.
Hui Jin, Ph.D.

CLARIFYING SUGAR–RECEPTOR BINDING

Cells in the body interact with each other and the matrix around them. One key mechanism of interaction is between complex sugar structures and their protein receptors, known as lectins. A pressing question in biology is how lectins recognize the many diverse types of sugar structures.

A team led by Virgil Percec now describes a way to test how lectins selectively bind to different sugar structures (DOI: 10.1021/jacs.5b08844). The investigators modify a class of monodisperse and sequence-defined polymers containing amphiphilic branched fragments known as Janus dendrimers with different types of sugar-containing structures. The modified polymers form particles called glycodendrimersomes, which enable the investigators to analyze how lectin binding depends on the sequence and density of different sugar structures.

The investigators work with Gal-8, a lectin that plays a role in cell migration, adhesion, and other important processes. By testing four forms of natural Gal-8 against eight different glycodendrimersomes, Percec and colleagues have determined that the human adhesion molecule Gal-8 prefers to bind to a defined low density sequence of the sugar lactose, a common epitope present on cell surfaces.

Given some earlier contradictory reports in the scientific literature on lectin's binding preferences, the authors note that their approach of using glycodendrimersomes can help clarify researchers' understanding of the functioning of the immune system and vaccines.
Rajendrani Mukhopadhyay, Ph.D.

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