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Variable nanocomposites

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What appear under an atomic force microscope to be tiny rings with little bits missing are actually nanoscopic rings made of double-stranded DNA with a little gap in the form of a short single-stranded fragment. As Michael Famulok and his team from the University of Bonn, Germany, explain in the journal *Angewandte Chemie*, this gap is a place to attach other molecules that have the potential to transform the rings into versatile nanocomposites for various applications.

The programmable aggregation of molecular building blocks into structures with higher order plays a key role in the construction of nanomaterials. Nucleic acids are interesting building block candidates, being easy to synthesize and exhibiting unique molecular recognition characteristics. The difficulty lies in the fact that the construction of defined two- or three-dimensional geometries requires rigid building blocks. However, DNA molecules are normally flexible structures.

“From the structural point of view, miniature rings represent the simplest form for a rigid object made of DNA,” says Famulok. His team thus took on the challenge of producing DNA molecules with a smooth circular structure, free of ring deformations, twists, or knots. This was not an easy endeavor. DNA is usually found in the form of a double strand with a helical twist and can, if it is too short, close on itself to form a ring.

On the other hand, if the ring gets too large, it is no longer rigid. Famulok and his team have now succeeded, by careful selection of the sequence and number of nucleotides as well as a clever synthetic route, in producing the desired rigid rings.

Even better, the researchers were able to build a “gap” into their rings—a short sequence that does not occur in normal base pairing, instead exiting as a single-stranded segment. This should make it possible to “fit” the ring with tailored functionality for special applications.

All that needs to be done is to produce a short single strand of DNA complementary to the single-stranded part of the ring and to attach it to a molecule with the desired properties. This single strand then fits perfectly into the gap. This allows the ring to be equipped as desired, depending on the requirements of the application in question. For example, it can be given “anchors” that precisely bind the rings to other components.

“Our new, uncomplicated method for the production of rigid DNA nanorings with variable, tailor-made functionality opens new pathways for the construction of DNA objects with higher levels of organization,” Famulok is convinced.

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