The single-stranded cargo can bind to any anchorage. Parts of the anchorage and cargo that remain single-stranded are held together to form a structure the researchers refer to as a "split-toehold," which not only signals the cargo's presence but identifies the current anchorage by displaying its address (a specific sequence of nucleotides). Cargo transfer is mediated by a DNA fuel molecule that provides both energy and a routing instruction; it carries address domains that mediate transfer of the cargo between two specific anchorages.

The researchers used a simple two-anchorage track to demonstrate the coupling of fuel hairpins to control cargo movement by sequential activation of split toeholds. A three-anchorage track was then used to demonstrate the control of directional transport by information stored in the fuel hairpins. Furthermore, a T-junction track with four anchorages and branch points was used to demonstrate that the DNA motor could navigate complex paths. The researchers said, "We have made a further step in the development of molecular robotics by showing that the behavior of an autonomous motor on a branched track can be programmed by a rewritable external program encoded in DNA."

Steven Trohalaki

Nano Focus

Thermodynamics predict enhanced vacancies formation in nanoparticles compared to the bulk

When an atom is lacking in a crystalline lattice, the thermal, electronic, and mechanical properties of the material change. In nanomaterials, these properties are not always easily measurable and theoretical studies can help researchers understand and predict modifications of the structure and properties of materials at the nanoscale. G. Guisbiers of the Catholic University of Louvain recently studied vacancies formation in nanoparticles with the help of classical thermodynamics.

Thermodynamics is a top-down approach that avoids many-body calculations. It is known to be relevant when the thermal fluctuations, proportional to the inverse square root of the number of particles in the system, are small. Thus, issues concerning nanoparticles with diameters down to 4 nm can be addressed by thermodynamics, as reported in the February 17th issue of the *Journal of Physical Chemistry* (DOI: 10.1021/jp108041q; p. 2616).

Guisbiers uses a universal equation linking the bulk property of a material and the size and shape of the particle to deduce the corresponding property in nanoparticles for a number of metals and semiconductors. Results show that vacancies form more easily in nanosized materials than in the bulk. In energetic considerations, this can be related intuitively to the augmentation of the surface-to-volume ratio, since vacancies can be thought of as internal surfaces.

"Even if the vacancy concentration of a nanoparticle increases compared to its bulk vacancy concentration, this model can also explain why nanomaterials appear to be perfect. It is due to the limited number of atoms in a particle," said Guisbiers.

The predicted increase in concentration of vacancies matches several experimental results. It leads to bond length contraction. This induces that nanomaterials are harder and possess higher yield strengths than bulk materials, a phenomenon known as the Hall–Petch effect. The higher concentration of vacancies also lowers phonon frequencies, an effect that is observed experimentally. It results in lower electronic and thermal conductivities due to enhanced electron and phonon scattering.

Guisbiers said that this study could help in the understanding of the formation of nanopores, widely used in nanotechnology applications.

Elsa Couderc

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