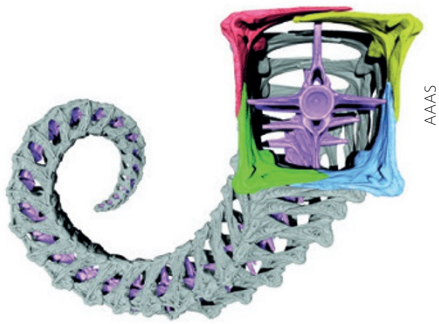
BIOMECHANICS

Square strength

Science **349,** 6243 (2015)



AAAS

Careful analysis of evolved systems in nature has previously revealed a number of novel design principles that might enhance the performance of artificial structures. Material hierarchy and mechanical structure are two examples of this. Now, Michael Porter *et al.* have found that the square cross-sectional structure of the tail of seahorses lends them an enhanced ability to mechanically grasp objects and to resist crushing from predators, as compared with a cylindrical cross-section. The authors use 3D printing to fabricate representative artificial tail structures with either square or circular cross-sections, and performed mechanical testing in combination with computational modelling to understand their performance and deformation mechanics. They find that the articulated rigid bony plates of a seahorse tail in a square configuration offer a great range of motion when bending, twisting or being crushed, helping to preserve mechanical integrity. This might provide a useful design strategy when fabricating mechanically robust and flexible architectures. *JP*

SPINTRONICS

Detecting the switch

Nature Phys. **11,** 570–575 (2015)

The spin Hall effect is a transport phenomenon, originating from the spin–orbit interaction, resulting in spin accumulation on the surfaces of a conductor when a current flows through it. In non-magnetic materials with large spin–orbit coupling, it can lead to significant spin accumulation at the interface between these materials and ferromagnets, whose magnetization can be switched as a result of the concomitant spin–orbit torque generated. Now, Can Onur Avci and colleagues show that the longitudinal resistance of Ta/Co and Pt/Co bilayers changes when the current flow is reversed or the sign of the magnetization is inverted, which is another consequence of the spin accumulation. The resistance is minimum if the spin at the interface and the magnetization of the cobalt layer are parallel, whereas it is maximum if they are antiparallel. This behaviour enables two-terminal spintronic devices to be produced where the current controls the magnetization and its switching is detected through resistance measurements. *DC*

INTRACELLULAR CHEMISTRY

Bioorthogonal catalysts

Nature Chem. **7,** 597–603 (2015)

The instability of catalysts in the complex environment within cells hampers the generation of intracellular molecules for imaging and therapeutic applications. Within this context, Vincent Rotello and colleagues now report supramolecular nanoparticles for the gated control of intracellular catalytic activity. The researchers encapsulated transition metal catalysts within the surface layer of polymer-functionalized gold nanoparticles, and used cucurbituril as a supramolecular surface coating to sterically inhibit catalytic turnover. Once endocytosed, the nanoparticles remain inert in cells until an adamantyl guest is added to trigger macrocycle displacement, exposing the catalytic metals. In the presence of an exogenous fluorophore precursor, the activated nanoparticles are able to catalytically produce a fluorescent measure of the intracellular catalytic reaction. They are also able to trigger cell death through the catalytic activation of a synthetic prodrug. This system may inspire further developments for the study and control of dysfunctional cells. *JH*

COLLOIDAL NANOCRYSTALS

Precursors take control

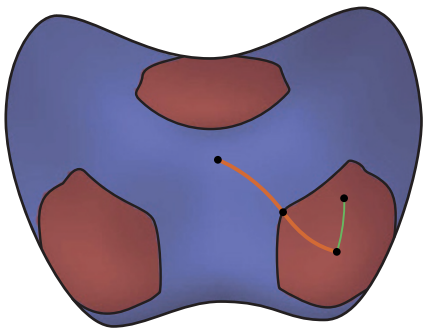
Science **348,** 1226–1230 (2015)

The possibility to tune the optical properties of colloidal nanocrystals by controlling their size is key for the versatile use of these emitters in optoelectronic applications. In standard protocols for the synthesis of metal chalcogenide nanocrystals, metal and chalcogen precursors convert into crystalline nuclei that grow until the desired size is reached; at this stage the reaction is interrupted, leaving part of the precursors unreacted. Mark Hendricks and colleagues now show that the dimensions of the nanocrystals can be controlled more efficiently by tuning the conversion reactivity of the chalcogen precursors and running the reaction to full conversion of the reagents. They synthesized thiourea precursors that react with lead oleate with reaction rates spanning more than three orders of magnitude, and showed that a high reactivity increases the amount of nuclei produced in solution; the higher the number of nuclei, the smaller the nanocrystals at complete conversion. The size and size dispersion are not affected by the overall volume of solvent, suggesting that this high-yield protocol can be effectively implemented on large scales. *LM*

MECHANICAL INSTABILITIES

Firmer free-energy

Nature Commun. **6,** 7559 (2015)



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Free energies are only strictly defined for equilibrium states, yet it is common to assume that the free energy of unstable phases can be extrapolated from the free-energy functional derived or computed for equilibrium states. However, extrapolation schemes do not always agree, and it can occur that extrapolated free energies for an unstable phase result in values lower than that of a stable phase. Now, A. van de Walle and colleagues describe a simple computational method to smoothly extend the free energy of stable solid phases into mechanically unstable ones without any need for extrapolation. The method relies on partitioning the phase space into 'neighbourhoods' on the basis of a criterion based on local curvature, and is shown to yield smoothly varying free energies that agree with those of known extrapolation schemes (for a benchmark ternary alloy system displaying three common cubic lattices). Computational-thermodynamic frameworks should benefit from the approach. *PP*

Written by David Ciudad, James Hennessy, Luigi Martiradonna, Pep Pàmies and John Plummer.