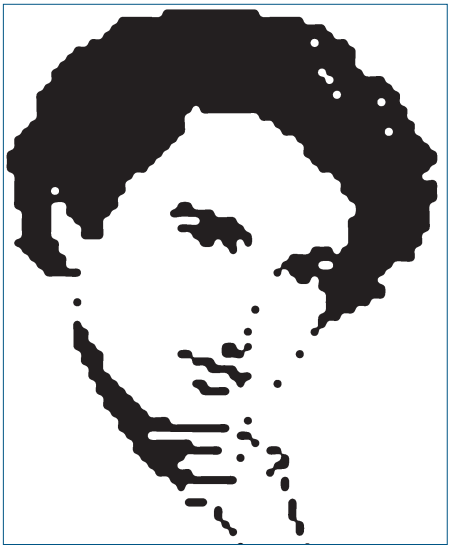
COMPUTING

Nothing more than DNA

Angew. Chem. Int. Ed. http://doi.org/f3qqgw (2016)



Rapid advances in DNA nanotechnology, along with the high data density and longevity of DNA, suggest that DNA computing may soon be more than a proof-of-concept technology.

Inspired by the biological regulation of epigenetic information (heritable changes in gene expression), Shankar Balasubramanian and colleagues at the University of Cambridge now show that a single DNA template can store multiple layers of binary data. The bisulfite-catalysed conversion of cytosine (C) to uracil (U) forms the basis of a two-layer binary encoding system. C positions that encode for 0 are turned to 1, and G positions that encode for 1 are transformed to 0. As the adenine and thymine positions are unaffected, the designed sequence gives different readouts before and after chemical treatment. This was demonstrated by the concurrent storage of the first two stanzas of *The Raven* by Edgar Allan Poe in a DNA sequence.

A three-layer encoding system was also achieved by introducing 5-hydroxymethylcytosine residues, which convert to U after $KRuO_4$ oxidation and bisulfite treatment. This allows the simultaneous encoding of the images of Rosalind Franklin, Charles Darwin and Alan Turing in a single piece of DNA. Chemical reduction can then be used to reversibly reveal any of the three images. *BLB*

SEMICONDUCTOR NANOCRYSTALS

How to get more photons

Nano Lett. http://doi.org/bn8f (2016)

Exciting semiconductor nanocrystals with laser light of the appropriate energy creates electron–hole pairs, also known as excitons, which after a certain time recombine, emitting light (photoluminescence, PL). The PL is due to the decay of single excitons and to the sequential decay of multiexciton complexes. The ideal ratio between these two types of emission varies according to the type of device the nanocrystals are used in. Now, Sadahiro Masuo and colleagues from Kwansei Gakuin University and Hokkaido University in Japan have demonstrated how a plasmonic nanostructure can be used to control the type of PL emitted by a single nanocrystal.

The researchers used an atomic force microscope (AFM) tip coated with silver as the plasmonic nanostructure. By decreasing the distance between the AFM tip and the nanocrystal they observed an increase in PL intensity, which they ascribed to an increased population of multiexciton complexes due to the interaction of electrons and holes in the nanocrystals with the surface plasmon on the tip. This hypothesis was confirmed by evaluating the second-order correlation function of the PL, which gives a direct measure of the number of single photons emitted, and showed an increased ratio of multiphoton to single-photon emission when the tip approaches the nanocrystal. *FP*

BIOIMAGING

Bigger and clearer

Nat. Biotechnol. http://doi.org/bn8d (2016)

Current imaging techniques such as proteomic imaging and expansion microscopy enable the characterization of the fine subcellular architectures of individual cells. However, the processing steps, which require protease digestion and tissue sectioning, cause the loss of proteins and the loss of intercellular connectivity. Researchers in the US and South Korea now report a new processing method that allows multiscale proteomic imaging of intact biological systems.

Kwanghun Chung and colleagues at the Massachusetts Institute of Technology, Yonsei University and Harvard University describe a tissue expansion method that preserves the 3D proteome content and organization, and the connections between the cells within an organ. The method, called magnified analysis of the proteome (MAP), involves the use of high concentrations of acrylamide monomers during a hydrogel-tissue hybridization step. Acrylamide prevents reactive hydroxymethyls — formed from the reaction between amine-containing residues on the protein and formaldehyde — from reacting with amide groups within the same protein or with adjacent proteins to form methylene bridges. Intra- and interprotein crosslinking can prevent complete denaturation and dissociation of the proteins and limit subsequent tissue expansion. Using the MAP technique, a whole mouse brain can be expanded fourfold within 7 days without any protease treatment. The 3D proteome of the expanded tissues can be labelled using conventional antibodies for super-resolution imaging of the fine subcellular architectures. One limitation of the method is that expansion decreases signal intensity. *ALC*

VAN DER WAALS HETEROSTRUCTURES

Photo-thermionic effect

Nat. Commun. **7,** 12174 (2016)

A metal–semiconductor junction can be used to detect low-energy photons, as the charge carriers photoexcited in the metal are injected into the semiconductor creating a photocurrent. However, the Schottky barrier at the interface sets a sharp lower limit for the photon energy required to trigger the process. Now, Frank Koppens and colleagues at the Institut de Ciencies Fotoniques in Spain and the National Institute for Materials Science in Japan demonstrate that a different mechanism is at work in vertical graphene–WSe_2–graphene heterostructures, ideally allowing them to harvest photons with energies smaller than the Schottky barrier.

The researchers exploit the strong electron–electron and weak electron–phonon interactions in graphene. These properties induce a fast thermalization of the photoexcited hot charge carriers and increase the effective temperature of the electronic bath. This causes the electrons to be injected from graphene into WSe_2 via the thermionic effect, generating a photocurrent that is then collected by a second graphene electrode.

The researchers can also tune the Schottky barrier using both a bias and a gating voltage, effectively controlling the intensity of the photocurrent. The thermionic effect is verified by the observation of an exponential dependence of the photocurrent on the Schottky barrier height and by a superlinear dependence of the photocurrent on the incoming laser power. *GP*

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