Electrostatic design

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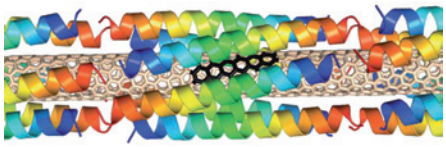
Peptide amphiphiles are known to self-assemble into a range of structures including ribbons and fibres. Some of these assembles have been shown to be bioactive. For example, peptide amphiphiles that incorporate the pentapeptide IKVAV can induce differentiation of neural stem cells into neurons and promote neural outgrowth, and hence are attractive materials for neural regenerative therapy. Now, Samuel Stupp and colleagues have shown that the presence of the IKVAV pentamer on the surface of peptide-amphiphile nanofibres leads to the aggregation of the fibres into bundles, which reduces the materials' bioactivity. By introducing charged amino acids into the middle section of the peptide amphiphile, they show that it is possible to suppress the interdigitation of the fibres into bundles and therefore significantly enhance the neural outgrowth observed on gels formed from the fibrous materials. The number of charged amino acid groups introduced was varied and shown to be critical in the determination of the binding ability to target receptors of the IKVAV pentamer and hence the resultant bioactivity of the material.

Superstructures on surfaces

Science **332,** 1071–1076 (2011)



Functionalization of molecular surfaces with protein-like ordered assemblies offers a powerful way to engineer the properties of hybrid nanomaterials. Designing such assemblies involves selecting the right functional groups and structural units for the targeted surface, as well as the appropriate packing interactions among them. Amidst the very large number of possible arrangements, the challenges are to identify a suitable packing geometry of the superstructure and to define the sequence of building units. To this aim, William F. DeGrado and colleagues proposed a computational approach based on three hierarchical rules: selection of (1) functional groups compatible with the surface, (2) structural units matching the surface's symmetry, and (3) optimum, stable interfaces between structural units. By applying the rules, the authors decorated carbon nanotubes with peptides that assemble into a predesigned helical pattern. The rules ensured that the physicochemical interactions between the surface and peptides, as well as the packing geometry and interactions, are favourable for the stability of the assembly. Furthermore, the designed superstructure directed the nucleation of a helical array of gold nanoparticles.

Toxicity with a twist

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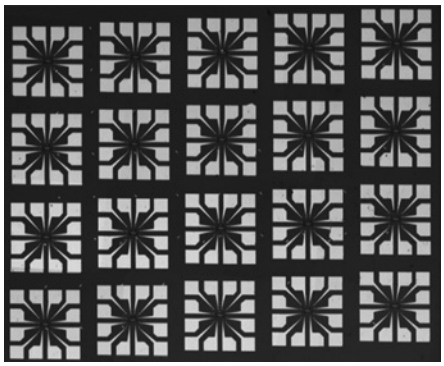
Semiconductor quantum dots with controllable size can be synthesized in large quantities, and their tunable optical properties and high fluorescence efficiency make them potentially interesting probes for biomedical imaging. However, such quantum dots are often based on toxic Cd or Pb compounds. They can induce cell death by autophagy — a metabolic process in which a cell's organelles are destroyed. To enhance their biocompatibility, quantum dots have hence been capped by organic ligands. Yiye Li and colleagues now report that the chirality of these ligands can have a significant influence on the cytotoxicity of the quantum dots. The researchers exposed human liver carcinoma cells to CdTe quantum dots that were capped with the two isomeric forms of the tripeptide glutadione. Although cell uptake was independent of ligand chirality, quantum dots capped with the D-isomer were less likely to induce autophagy than the L-isomer. Although cell viability could not yet be enhanced to unity, the findings may enable the development of more biocompatible quantum dots for imaging applications.

Graphene spintronics for real

Nano Lett. **11,** 2363–2368 (2011)



One of the many properties of graphene is that even at room temperature the relaxation time and length of the electron spin are very high, which is promising for the use of this layer of carbon atoms in spintronics. Unfortunately, these excellent properties were demonstrated with exfoliated graphene flakes, which are not scalable and therefore not very useful for practical devices. Ahmet Avsar and colleagues have now shown that similar results can be obtained in devices fabricated in a potentially scalable way. They fabricated large arrays of spin valves based on single- and bilayer graphene grown by chemical vapour deposition. They found spin-relaxation lengths higher than 1 μm and spin-relaxation times higher than 100 ps, both comparable to the results obtained with exfoliated graphene. The results represent a real demonstration that graphene could be used not just in proof of principle, but also in realistic spintronics devices.

Silicon does it

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The poor light emission from silicon is notorious. Even though silicon is the key material for computer processors, its almost non-existent light emission has been a major obstacle in implementing photonic capability on electronic chips. Various approaches enhance this emission, but the lack of a straightforward solution that functions efficiently at room temperature has hampered progress. Matteo Galli and colleagues have now demonstrated strongly enhanced room-temperature light emission at telecommunications wavelengths from a silicon photonic crystal. The photonic crystal has a cavity embedded in its structure, where the periodic structure of the crystal is broken, so that light emission at a specific wavelength within the otherwise forbidden photonic gap is allowed. Therefore, silicon light emission is strongly confined and enhanced — in the present case by a factor of 300. Moreover, there is only a twofold reduction of this emission at room temperature compared with cryogenic temperatures. At present, the scheme is all-optical, and electrical operation will be needed for actual circuits. Nevertheless, these results suggest a promising role of photonic crystals in silicon optoelectronic applications.