ENVIRONMENTAL NANOTECHNOLOGY

Plastic not so fantastic

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Credit: Maciej Bledowski / Alamy Stock Photo

Pollution from microplastics, particles of plastic smaller than 5 mm in size, poses a serious threat to a range of ecosystems. Due to their increased toxicity, it is important to make a distinction for nanoplastics with size ranging between a few tens and a few hundreds of nanometres. Nanoplastics are difficult to detect, so providing an estimate of their concentration, size and composition is challenging. More generally, there seems to be no real consensus on the methods used to identify and classify plastic particles of all sizes.

Mintenig et al. now propose a general framework for the analysis of both micro- and nanoplastics. This framework consists of a sampling step to generate a density of particles high enough to be detected, a sizing step and an identification step to establish the type of polymers in the particles. For particles larger than 20 μm, common methods can be used for all three steps. For smaller particles, the team propose crossflow ultrafiltration, a method used in medical dialysis, for sampling. Asymmetrical flow field-flow fractionation can be used for sizing, and pyrolysis gas chromatographic-mass spectroscopy can be used for the identification of the composition.

The three steps were tested by using known nanoparticles as small as 50 nm in size. Though some improvements will be necessary, the results show that the proposed framework could indeed be used as a general method to quantify and analyse plastic particles of a wide range in size. *FP*

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CELL ENGINEERING

Setting up boundaries

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By spatially isolating specific reactions, compartmentalization has allowed eukaryotic cells to achieve their high level of complexity. Artificial orthogonal compartments built via protein self-assembly might offer a similar level of control over engineered, non-native metabolic pathways for the generation of valuable products that need to be segregated from the rest of the cell. However, contrary to prokaryotes, eukaryotes do not possess proteins that can spontaneously perform such a task.

To tackle this issue, Sigmund and colleagues express the bacterial encapsulin shell and cargo protein system in human embryonic kidney cells. Even in this unfamiliar cellular environment, the system behaves as predicted, with the shell protein self-assembling into nanocompartments that encapsulate the native cargo proteins, with no apparent cytotoxicity. The system lends itself to different applications. By targeting native ferritin-like cargos the nanocompartments can sequester iron, functioning as genetically expressed contrast agents for magnetic resonance imaging, or as markers for electron microscopy. A modified version of the encapsulin nanocompartment can target destabilized proteins, shielding them from proteosomal degradation. Finally, the nanocompartments can be exploited to perform enclosed enzymatic reactions, such as the one producing melanin, a toxic metabolite used for cell imaging. *CP*

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MOLECULAR ELECTRONICS

Longer wires conduct better

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The conductance of a classical metallic cable is inversely proportional to its length. In contrast, molecular wires usually act as tunnelling barriers where the conductance decays exponentially with length. Algethami and co-workers now show theoretically that, in some cases, the conductance can actually increase with the length of the molecular wire.

Density functional theory-based simulation is used to explore the electronic transport through fused porphyrin oligomers. The molecules, which are known for their good electron transmission, are anchored to either graphene or gold electrodes. The researchers compare the conductance of different oligomers as a function of the Fermi level alignment. When using gold electrodes, the conductance can either increase or decrease with the length, depending on the anchoring group used to couple the molecule to the electrode. For graphene electrodes, however, the conductance increases with the length, independent of the molecule–electrode bonding. Algethami et al. attribute this to the strong coupling between the porphyrin units which yields a sizeable reduction of the gap between the highest occupied and the lowest unoccupied molecular orbital. The reduced transport gap overcompensates the decay of tunnelling conductance with length, at least up to six fused porphyrin units. *BH*

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OPTOELECTRONICS

Low-dimensional perovskites

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The discovery of two-dimensional (2D) Ruddlesden–Popper halide perovskites (RPPs) has given new momentum to perovskites optoelectronics. Yet to enable a rapid technological progress towards their practical use a better understanding of many fundamental aspects, including the nature of their optical resonances, is urgently required. Now, Blancon et al. have developed and experimentally verified a model able to quantitatively describe thickness-dependent optical transitions in layered RPPs.

First, the researchers conduct low-temperature magneto-absorption measurements to extract the exciton reduced mass for 2D RPP crystals, with the number of constituting perovskite layers varying between one and five. This parameter serves as an input to build a theoretical model that accurately describes the electron–hole Coulomb interaction in thin semiconductors by taking into account the effects of dielectric confinement. The proposed model provides a theoretical solution to the binding energy of the exciton ground state and indicates the existence of a universal thickness-dependent scaling behaviour. Being of critical importance for the operation of perovskites optoelectronic devices, this fundamental parameter can be computed for any given number of perovskite layers based on the deduced scaling law. *OB*

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