OCTOPUS-INSPIRED NANOSUCKERS

Adhere to the rough and wet

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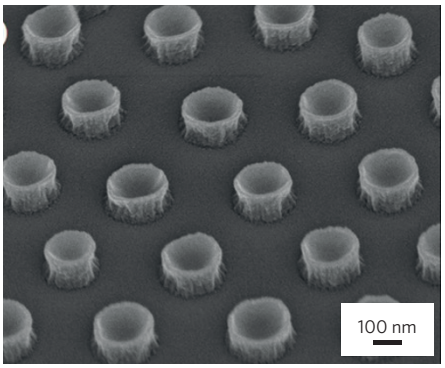

AMERICAN CHEMICAL SOCIETY

Octopus arms can adhere to various surfaces in marine environments because of their periodic, non-close-packed, centimetre-scale suckers. However, existing octopus-inspired artificial suckers still suffer from reliance on suctioning systems and power sources or poor applicability to rough surfaces and wet environments. Ying-Chu Chen and Hongta Yang now report the assembly of nanosucker adhesive arrays, capable of adhering to both microrough and flat surfaces in dry and wet environments.

The researchers spin-coat silica colloidal crystals into a hexagonal-ordered non-close-packed pattern within ethoxylated trimethylolpropane triacrylate (ETPTA) matrix on wafer. They subsequently embed the silica particles into a poly(vinyl alcohol) (PVA) film and peel them off from the ETPTA on the wafer. The templated PVA film then acts as a mould for PDMS nanosucker array fabrication (see scanning electron microscope image). The fabricated flexible nanosuckers can seal to even/uneven surfaces in dry/wet environments driven by the van der Waals force and a negative pressure effect when they are pressed to release the internal air. The adhesive arrays exhibit great resistance to both perpendicular and shearing forces for multiple cycles. However, the adhesion decreases with time due to air permeation through the PDMS film that reduces the pressure differential. *WS*

NITROGEN-VACANCY CENTRES

Driven by the environment

Phys. Rev. Lett. **118,** 167204 (2017)

The coherent control of a spin qubit state and its time evolution between two quantum levels is usually achieved by the application of an external a.c. magnetic field whose frequency matches the separation between the energy levels resonantly. Simultaneously, local fluctuations induced by the surrounding electronic environment limit the intrinsic quantum coherence of the qubit — a detrimental condition for the implementation of quantum computation algorithms.

Now, Lillie *et al.* report on so-called environmentally mediated resonance — a double-resonance process where direct coherent control of the electronic environment of a single qubit is indirectly transferred to the qubit itself. In their proof-of-principle demonstration, the reference qubit is encoded in a single nitrogen–vacancy centre ~10 nm below the surface of a diamond crystal, while free electrons on the surface are considered as the environment. A static magnetic field ~1 kOe is used to induce spin resonance processes in free electrons at ~2.87 GHz while preventing direct resonant absorption by the nitrogen–vacancy centre. By tuning the intensity of the a.c. magnetic field, the researchers match the frequency of the induced Rabi oscillation in free electrons to the characteristic resonant frequency between $|m_s = 0\rangle$ and $|m_s = -1\rangle$ states in the qubit, providing evidence for its indirect coherent control. *GP*

CYCLIC POLYMERS

A self-assembly route

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Because they lack end groups, cyclic polymers have intrinsically different physico-chemical properties than their linear counterparts. But achieving cyclic polymers usually requires a major synthetic effort; as a result, only a limited number have been reported. Now, Aoki *et al.* have devised a route to synthesize cyclic polymers with quantitative cyclization yield.

There are two main strategies to make cyclic polymers: cyclization of a linear polymer or ring-expansion of a cyclic molecule. The first strategy is marred with low selectivity during the end-to-end coupling, whereas the second usually requires multiple synthetic and purification steps. Aoki *et al.* propose to start with a short linear oligomer containing an ammonium group and ending with a crown ether macrocycle. Two of such molecules self-assemble quantitatively to form a [c2] daisy chain, where the oligomer threads inside the crown ether thanks to the interaction between the crown ether and the ammonium group. Then, a living polymerization reaction elongates the initial oligomer to a desired extent. Finally, the reaction is quenched by the introduction of a bulky end group with a urethane moiety. At this point, the ammonium group is oxidized to release the crown ether, sliding it to the urethane groups, yielding the final cyclic polymer. Aoki *et al.* demonstrate gram-scale synthesis of these polymers with 72% yield. *AM*

NEUROMORPHIC COMPUTATION

Lowering dimensions

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Dimensionality reduction is a fundamental aspect of machine learning algorithms. It involves the approximation of high-dimensional multivariate input data as a compact combination of few fundamental elements in a process known as feature extraction, leading to more-efficient information storage and analysis. Feature extraction has wide implications for predictive modelling based on big data sets — however, it is computationally intensive.

Now, Choi *et al.* report on the efficient exploitation of neuromorphic hardware architectures to perform principal component analysis — a linear version of the feature extraction algorithm. The researchers fabricate a 9 × 2 crossbar array of memristors based on 10-nm-thick Ta_2O_5 switching layers sandwiched between NiCr/Pd and Ta/Pd electrodes. These memristors are analogue and their resistance state can be adjusted incrementally by the application of voltage pulses affecting the oxygen vacancies profile in Ta_2O_5.

Each of the nine rows of the memristor array is fed with an input voltage pulse. Encoded in the duration of each pulse is one specific mass property of a cell and, in an initial training process based on a breast cancer cell database, the researchers use 100 nine-input sets — relative to 50 benign and 50 malignant cells. The trained network then allows the researchers to analyse ~600 unlabelled data sets. A clustering analysis based on the learned features shows that the unsupervised learning process in the array led to successful classification of benign and malignant cells in ~97% of cases. *GP*

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