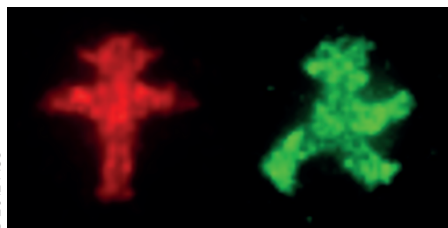


PROTEIN NANOSTRUCTURES

Cut and paste

J. Am. Chem. Soc. **134**, 15193–15196 (2012)



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Protein nanostructures are important in the development of applications such as biosensors and in the study of systems such as enzyme networks. However, the properties of these assemblies are affected by the arrangement of the biomolecules within the structure and the controlled assembly of precise nanostructures is challenging. Diana Pippig and colleagues at the University of Munich have now shown that patterns of proteins can be formed one molecule at a time using a technique called single-molecule cut-and-paste.

The researchers used green fluorescent proteins that were initially bound to DNA anchor molecules in a ‘depot’ area of a glass substrate via DNA hybridization. A structural motif known as zinc fingers is incorporated into the biomolecules, which allows them to connect to the DNA anchors through complementary DNA connector strands. An atomic force microscope with an antibody fragment covalently attached to its tip is used to pick up the proteins from

the depot. The tip binds to a small antigenic peptide tag on the protein and when the tip is retracted the DNA is unzipped. The protein units can then be transferred to a target area on the substrate and deposited at a specific site through hybridization of the connector DNA with a target DNA anchor.

To illustrate the capabilities of the technique, Pippig and colleagues used 900 cut-and-paste cycles to assemble a micrometre-sized pattern of a red-traffic-light man. The DNA connectors are labelled with a dye molecule and their red emission was recorded with a fluorescence microscope. A green man pattern was then assembled and the green emission of the proteins recorded. OV

CHIRAL NANOSTRUCTURES

A two-step affair

Angew. Chem. Int. Ed. <http://doi.org/fz6jrh> (2012)

A tiny and usually undetectable amount of chiral contaminant can induce racemic or achiral mixtures to become optically active as the molecules in solution self-assemble into supramolecular aggregates. Observations of chiral amplifications of this type have been reported by several groups and may help explain the emergence of homochirality in nature. Now, Rint Sijbesma, Anja Palmans, Bert Meijer and colleagues at the Eindhoven Institute of Technology have discovered a unique chiral amplification that takes place in two consecutive steps.

The researchers synthesize a partially fluorinated achiral compound composed

of three branching units stemming off a benzene core. One of these units contains an alkyl chain that is completely fluorinated, except for one terminal hydrogen. In solution, as the temperature is decreased, the molecule aggregates to form a racemic mixture of helical structures in a self-assembly process driven by hydrogen-bond interactions. However, on further cooling, larger aggregates form through hierarchical self-assembly of the helices to produce fibre bundles that are about 60 nm in diameter. These nanostructures are found to provide an optically active solution.

The second self-assembly step is driven by the intermolecular dipole–dipole interaction between the electron-poor terminal hydrogen and the fluorine atoms from neighbouring helices. However, the predominant handedness of the bundles seems to be influenced by chiral traces. AM

CARBON NANOTUBES

The long and the short

ACS Nano **6**, 8424–8431 (2012)

Growth conditions and processing can affect the lengths of single-walled carbon nanotubes, which can, in turn, impact cellular uptake and the performance of nanotube-based devices. Atomic force microscopy and dynamic light scattering are widely used to characterize the lengths of nanotubes, but these methods are either tedious, sensitive to artefacts from aggregates and impurities, or offer only average lengths rather than full length distributions. Bruce Weisman and colleagues have now shown that length distributions can be obtained by analysing the diffusional motions of individual nanotubes.

The researchers – who are based at Rice University, Ensysce Biosciences and the National Institute of Standards and Technology — placed a drop of a suspension enriched with the (6,5) species of single-walled carbon nanotubes in a microwell and imaged the individually diffusing tubes using a near-infrared video microscope. Using customized image analysis software, the trajectories and diffusion coefficients of the nanotubes were analysed. From this the length distributions could be calculated and were found to be in good agreement with results obtained from the conventional atomic force microscopy method. Furthermore, the technique was able to characterize approximately 800 nanotubes in about 2 h and is less susceptible to artefacts. ALC

Written by Ai Lin Chun, Alberto Moscatelli, Fabio Pulizzi and Owain Vaughan.

GRAPHENE

Silica in between

Nano Lett. **12**, 4503–4507 (2012)

Almost immediately after the discovery of the extraordinary transport properties of graphene it was realized that using this material in devices required the synthesis of large-area, high-quality single-layer sheets. Among the various procedures attempted so far, growing graphene on metal surfaces seems to be the most promising. Unfortunately, the electrical conductivity of the metal substrate masks that of graphene. The issue can be overcome by transferring the material to an insulating substrate, but this usually degrades the quality of the graphene. Rosanna Larciprete, Philip Hofmann and colleagues have now developed an elegant solution to the problem by inserting a layer of silica between the graphene and the metal substrate to isolate them electrically.

The researchers — who are based at various institutes in Italy and Denmark — first grew graphene on a ruthenium surface using a commonly used procedure. Then they exposed it to a silicon atmosphere at very high temperature (720 K). X-ray photoemission spectroscopy (XPS) confirmed the formation of a ruthenium silicide layer under the graphene sheet, and subsequent exposure to an oxygen atmosphere induced the formation of a silica layer, which was also confirmed by XPS.

Intercalation of various elements, including silicon, between graphene and metal substrates has been demonstrated before, but the intercalation of silica ensures electrical isolation of graphene. This was corroborated by resistance measurements, which recorded resistances much higher than that expected for ruthenium but typical of a two-dimensional conductor. FP