“SP1 PROTEIN-NANOPARTICLE HYBRIDS AS BUILDING BLOCKS FOR NANOSTRUCTURES: MEMORY ARRAYS AND NANOWIRES”

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SP1 nanostructures: (a) The X-ray structure of the SP1. (b) A computer image of the SP1-nanoparticle hybrid. (c) An AFM image of an SP1 molecule. (d) A close packed hexagonal SP1 array and enlargement. (e) TEM image of SP1 nanotubes (width 10 nm).

Controlled formation of complex nanostructures is one of the main goals of nanoscience and nanotechnology. SP1 (Stable Protein 1) is a boiling-stable ring protein complex, 11 nm in diameter, which self-assembles from 12 identical monomers. SP1 can be utilized to form large ordered arrays; it can be easily modified by genetic engineering to produce various mutants; it is also capable of binding gold nanoparticles (GNPs) and thus forming protein-GNP chains made of alternating SP1s and GNPs. We form those nanostructures and characterize them by transmission electron microscopy (TEM), atomic force microscopy (AFM) and electrostatic force microscopy (EFM). Further control over the GNP inter-distances within the protein-GNP chains may lead to the formation of nanowires and structures that may be useful for nanoelectronics.

Proteins as a mean of a versatile isolating template on one hand and a nanoparticle (NP) as an electric storage device on the other hand have long been investigated as independent entities. The ability to combine the two species to form an addressable single nanoparticle isolated from a conductive surface and adjacent NPs gives rise to a wide range of nanoelectronic devices. For this purpose we have connected a 5 nm SiO₂ NP to the SP1, and investigated the electric storage capabilities of the hybrid using Conductive AFM (cAFM). Such memory unit is capable of storing at least 3 states (0, 1, -1). With storage time of over 10 min at room temperature this hybrid can be considered as a nanometric memory unit.
The SP1-nanoparticle hybrids can form long nanotubes in which the SP1 protein serves as a template for an ordered chain of nanoparticles. This chain, when optimized, can serve as a conductive wire and potentially, by using a different nanoparticle in specific positions, as a chain of embedded devices. More complex architectures based on such wires may be very attractive for nanoelectronic applications.

Reference: