

Protein-based nano-structure fabrication : the Bio Nano Process

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Abstract

We have proposed a biological nanodevice fabrication process, which was named “Bio Nano Process” (BNP). The BNP produces nano-device key-components by biomineralization and self-organization of natural/artificial protein supramolecules. Protein supramolecules work as templates for the synthesis of homogenous nanoparticles (NPs) / nanowires (NWs) of metal-complexes and semiconductor materials. The chemically or genetically modified outer surfaces makes the bio-conjugates (protein+NP/NW) self-organize into functional nano-structures on a substrate. The addition of site specific binding peptides to the protein supramolecule is very powerful method to control both protein-protein and protein-substrate interactions. All process are carried out in aqueous solution, under ambient pressure and room temperature, which means that the BNP is a green process and environment-friendly.

We have already designed and produced several kinds of protein supramolecules for the BNP. Applying those, we have produced a floating nanodot gate memory (FNGM), a single electron transistor, a Re-RAM, bio-sensors, dye-sensitized solar cell, thermoelectric devices and other electronic devices. Moreover, by combining the BNP and nano-etching, we fabricated arrays of silicon nanodisks which were ideal quantum wells and are under investigation for quantum solar cell application. Proteins which have two types of site-specific binding abilities were genetically produced and the obtained proteins, “Porter Protein”, catch and deliver NPs / NWs to the specific patterns on a substrate. It is also expected that the BNP is well suited for plastic substrate devices.

We are now trying to expand the BNP frontier further. To realize such targets, it is true that we need more exploration into the nano-space, where solid material surface and a cluster of biomaterials or proteins interfaces interact coordinately. This interactive bio-interface was named “Active Bio Field”. The combination of conventional technologies and the BNP are now producing and will produce nano-devices efficiently and economically, which could not be realized in their absence.

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