Metallization of Polypeptide Arrays for Molecular Interconnect Applications

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METALLIZATION OF A BIOMOLECULE

Multiple routes have been explored for the metallization of a genetically engineered molecule composed of a repetitive polypeptide sequence $[(GA)_3GY(GA)_3GE(GA)_3GH(GA)_3GK$ where G=glycine, A=alanine, Y=tyrosine, E=glutamic acid, H=histidine, and K=lysine] folding in a ß-sheet.[1] The following paper focuses on the electrostatic attachment of cationic metallic nanoparticles to anionic portions of the polypeptide.

SYNTHESIS

Metallic Nanoparticles. Following the method proposed by Yonezawa *et al*.,[2] gold nanoparticles were capped with thiocholine bromide (TCB) ligands. The ligands served to stabilize and to cationically charge the nanoparticles. Transmission electron microscopy analysis (not shown here) revealed an average capped-nanoparticle diameter in the range of 3 to 5 nm.

Polypeptide Array. The desired sequence of polypeptides was first reduced to a corresponding DNA sequence. Repetitive coding DNA sequences were constructed by unidirectional oligomerization of the monomer and oligomerized units. Prepared units were ligated in a head-to-tail manner in the presence of adaptors for cloning into recipient plasmids. Amplification of these units was accomplished through well-established biochemical techniques. The constructed DNA sequences cloned in expression vectors were expressed in *E. coli* hosts. After polypeptide expression, the cells were collected, lysed, and purified using Ni-NTA columns.

EXPERIMENTAL RESULTS

UV-vis Spectroscopy. UV-vis spectroscopy was performed on an aqueous solution containing TCB-capped gold nanoparticles and the polypeptide (referred to as YEHK x 21). Data was gathered using a Hewlett-Packard HP8452 ultraviolet-visible spectrometer.

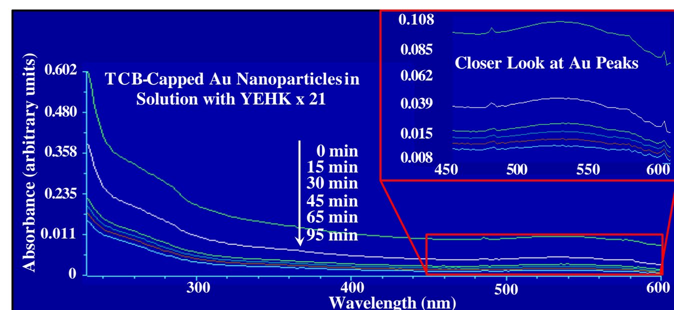

Figure 1. Series of UV-vis spectra disclose a progressive decrease in the polypeptide absorbance concomitant with a decrease in the gold absorbance.

Atomic Force Microscopy. Atomic force microscopy was performed on a graphite substrate that had been exposed to an aqueous solution containing TCB-capped gold nanoparticles and the polypeptide (YEHK x 21). The polypeptides were aligned using a "molecular combing" method previously described in literature.[3] Microscopy was performed using a Digital Instruments Nanoscope.

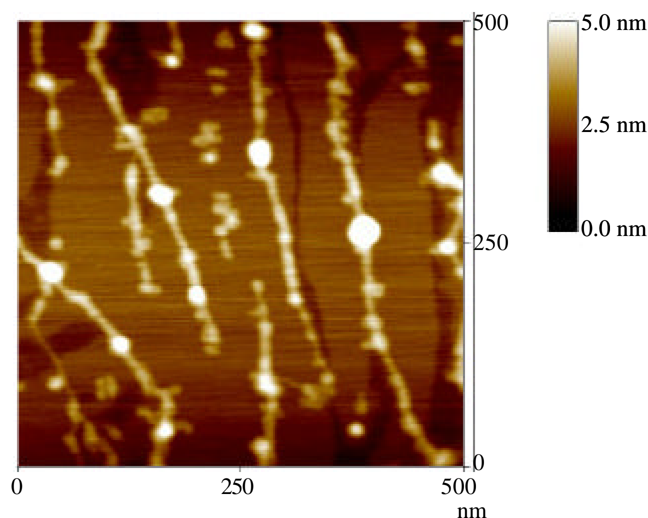

Figure 2. Atomic force microscopy image produced by the tapping mode analysis of a graphite substrate exposed to a solution containing TCB-capped gold nanoparticles and the polypeptide (YEHK x 21). Scan size: 500 nm, height: 5.0 nm.

DISCUSSION

UV-vis Spectroscopy. A decrease in the concentration of soluble peptide with a consequent loss of intensity of the UV-vis absorption spectra provides preliminary indication of an interaction between the TCB-capped gold nanoparticles and the polypeptide in solution. This decrease in intensity of UV-vis absorption is consistent with published behavior of metallic-nanoparticle/DNA interaction.[4]

Atomic Force Microscopy. Arrays of peptides form distinct ribbon-like structures. The appearance of larger, spherical structures suggests the attachment of the TCB-capped nanoparticles to the underlying peptide ribbon.

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