Recent Advances in Programmed Materials Synthesis with DNA

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The current commercial technology for fabrication of microelectronics and micromechanical devices employs photolithography as the main method of patterning.[1,2] Photolithography has proven to be extremely useful and versatile. However, this method has some limitations which are important to consider. Prominent among them are difficulties in adapting the technique for patterning on curved surfaces, as well as a size limitations imposed upon the structures by the wavelengths of light used in the microfabrication.[3] To push the feature sizes to smaller and smaller dimensions would require overcoming significant technical and economic obstacles; therefore scientists are motivated to seek other methods for nanostructure engineering.

DNA is of special interest to materials scientists because of its ability to associate with and recognize other DNA molecules by means of specific base pair binding,[4] thus making DNA an especially promising candidate as a molecular building block for programmed assembly of devices.[5] One of the earliest studies of using DNA to arrange molecular components was demonstrated by covalently attaching proteins to DNA to create DNA-protein conjugates.[6]

The unique optical properties of gold colloids have been studied for over one hundred years.[7,8] The assembly of DNA derivatized gold colloids was reported by Alivisatos[9] and Mirkin[10] shortly after the research on DNA-protein conjugates. These assemblies showed distinct alignment of gold nanoparticles on DNA strands, and reversible aggregation behaviors previously not observed with well studied alkanethiol assemblies.[11]

Methods for DNA-colloid assemblies were found to be adaptable for nanorods[12] as well as 2-dimensional networks,[13] further demonstrating the versatility of DNA in nanoscale patterning. When used as a molecular template, DNA was observed to act as a backbone that directs and promotes the deposition of silver ions to create a silver wire, Fig. 1.

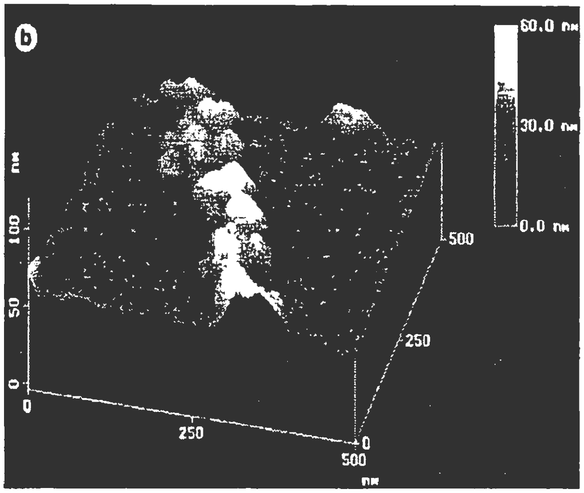

Fig. 1

The potential of using DNA as a molecular assemblier of nanoparticles and proteins is unparalled and has generated intense interest and research in this field. However, researchers need to address some important techniçal obstacles in order to narrow the gap between desire and reality. These include increasing the availability of large amounts of ultrapure synthetic DNA, as well as refining analytical methods for characterization of DNA nanostructures.

References

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