

A State of the Art Review on DNA-Based Applications in Nanobiotechnology

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ABSTRACT: In manufacturing and constructing nanostructures and computers, biological molecules such as deoxyribonucleic acid (DNA) have shown great promise. It is also a very suitable molecule for programmed self-assembly thanks to the very properties that make DNA as powerful as genetic material. To build metallic nanowires and functionalized nanotubes, the use of DNA to assemble metals or semiconducting particles has been expanded. This paper highlights some important aspects of combining the unique physical properties of dots or wires with the remarkable DNA recognition capabilities that could lead, including biosensors and probes, to miniaturizing biological electronics and optical devices. There is talk of attempts to use DNA-based nano carriers for gene delivery. The ecological benefits and hazards of nanotechnology, including DNA-based nanobiotechnology, are also assessed. In order to understand and transform bio systems (living or non-living), nanobiotechnology utilises nanoscale concepts and techniques and uses biological principles and materials to construct new nanoscale-integrated devices and systems. In the next few years, the convergence of nanotechnology with biotechnology as well as cognitive science and information technology is predicted to grow exponentially.

KEYWORDS: Applications, DNA, Devices, Nanotechnology, Systems, Semiconductors.

INTRODUCTION

Depending upon the nature and meaning of each application, nanoscience and nanotechnology are defined differently. "The Royal Society of the United Kingdom distinguishes between nanoscience and nanotechnology, where the former includes the "research and manipulation" of nanoscale particles and systems, and the latter, at the nanoscale ($1 \text{ nm} = 10^{-9}$ meters, or one billionth of a metre), the "design, characterization, and development of structures, devices and systems[1].

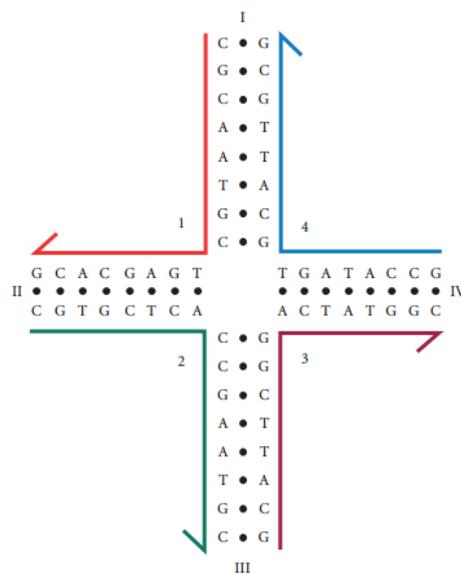


Figure 1: Illustrates the sequence of an immobile 4-armed DNA junction[2]

At the atomic, molecular, or macromolecular stage, nanoscience and nanotechnology include research and technology advancement on a length scale of approximately 1 to 100 nm. This may result in the idea of renaming biology and chemistry (molecules) nanosized objects as small machines[3].

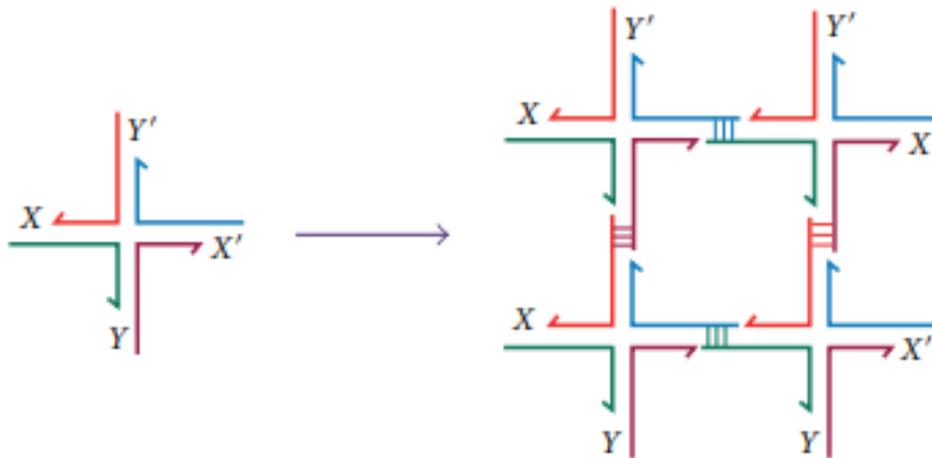


Figure 2: Illustrates the formation of two dimensional lattice from a four-arm junction with sticky ends[4]

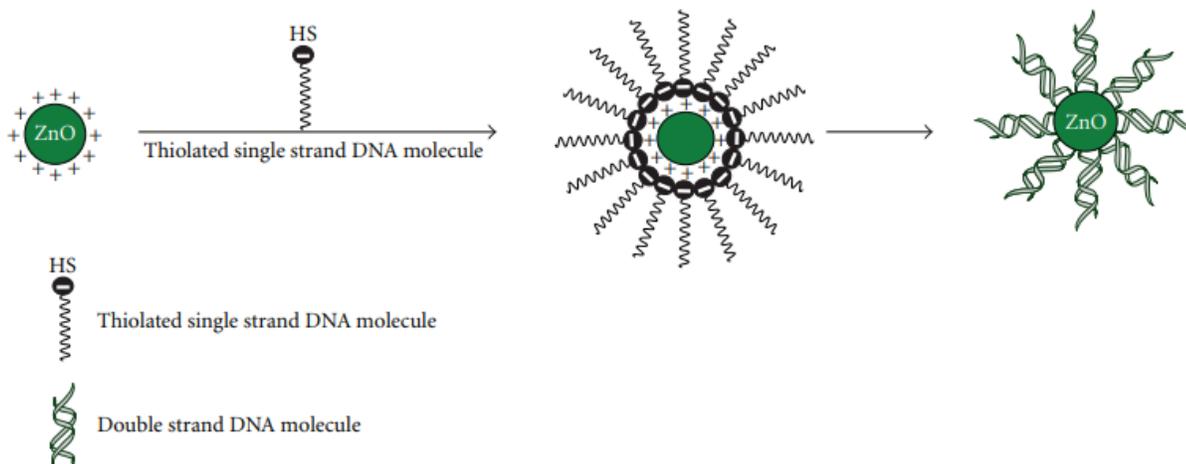


Figure 3: Illustrates the schematic presentation of immobilization of thiolated single-stranded probe DNA[5]

In choosing an immobilization technique appropriate for building nano devices such as bio-electronic devices, the attachment of biomolecules such as DNA to the surface of nano materials plays a crucial role. Some general aspects of using the immobilization technique include long-term usage, quick response, operational reliability and reproducibility of the electrochemical bio recognition case. The selection of the most suitable immobilization protocol is strictly based on the transducing nanomaterial characteristics, and robust immobilization chemistries are typically favoured in order to avoid desorption from the sensing layer of the probes[6].

DISCUSSIONS

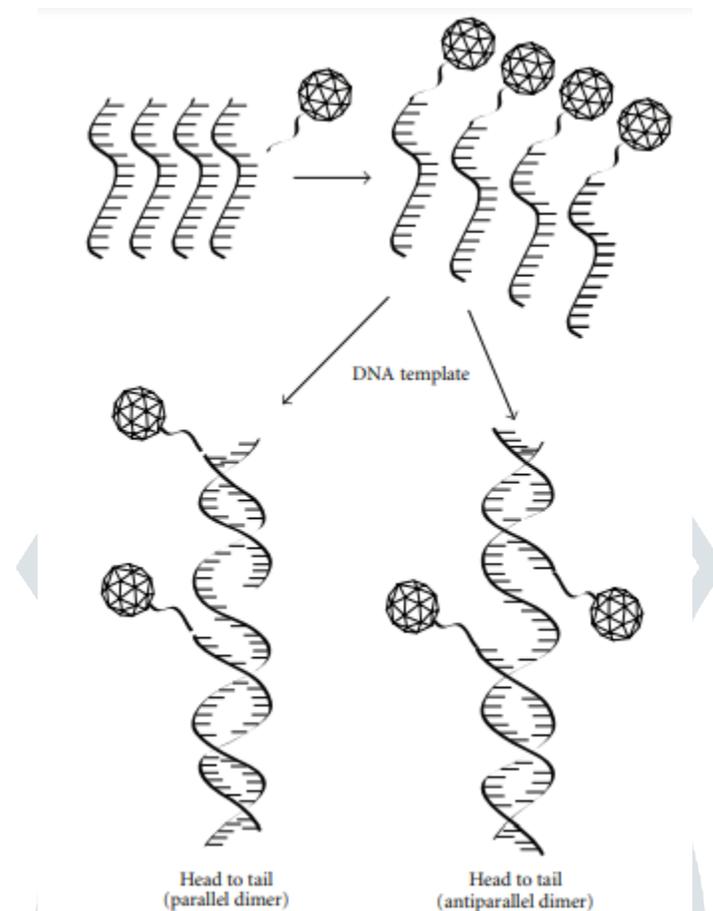


Figure 4: Depicts the organization of gold nanocrystals into spatially defined structures.

High energy ball milling, solution-based chemistry, mechanical-chemical processing, etching, electro explosion, and sonic and physical and chemical vapour deposition techniques are methods for generating nanoparticles from bulk materials[7]. The cornerstone of silicon integrated chip technology is patterned structures grown by effective lithographic and ion implantation techniques[8]. However, due to real physical constraints, including atom size, wave length of radiation used for lithography, and interconnection schemes, traditional technologies such as the photolithographic process are difficult to continue to scale down. It is also clear that to overcome this obstacle to miniaturization, an alternative solution based on perhaps entirely different concepts, such as the bottom-up approach, would be appropriate. Figure 1 illustrates the sequence of an immobile 4-armed DNA junction[9]. Figure 2 illustrates the formation of two dimensional lattice from a four-arm junction with sticky ends. Figure 3 illustrates the schematic presentation of immobilization of thiolated single-stranded probe DNA. Figure 4 depicts the organization of gold nano crystals into spatially defined structures.

CONCLUSION

Due to its unique structural, physicochemical properties, and recognition capacities, the study of DNA-based nanostructure is an attractive field. The use of DNA to prepare nanostructured materials and the use of such nanostructures for different biochemical and medical applications are defined in this study. Various DNA-based nanostructures are identified, including DNA-based nanostructures, DNA-based metal and semiconductor nanoparticle assemblies, DNA functionalized nanowires, and nanotubes. Also presented are some fascinating and promising examples of using DNA-based nanostructures as biosensors and gene

delivery systems. However, more work should focus on clarifying the mechanism of interaction between nano-materials and biomolecules, such as DNA, on the surface of multifunctional or homogeneous nano-films and nano-electrodes, in order to explore the possibility of using novel properties to create new biosensor generations. New useful nanostructures based on DNA are anticipated to begin to emerge over the next few years. In addition to providing valuable fundamental information on their collective biochemical, electrical, magnetic and electrochemical properties, their research at various nano-levels will also provide access to new and useful applications in the biosensors, food analysis, process control, environmental monitoring, diagnostics and disease treatment industries.

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