National Aeronautics and Space Administration

Rapid Polymer Sequencer

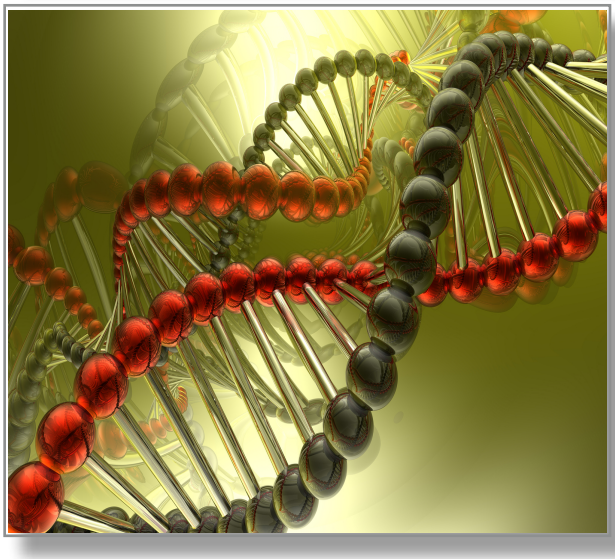
technology opportunity

Device sequences single molecules at a rate of a million bases per second

Solid-state nanopore-based analysis of nucleic acid polymers is revolutionary. No other technique can determine information content in single molecules of genetic material at the speed of 1 subunit per microsecond. Because individual molecules are counted, the output is intrinsically quantitative. The nanopore approach is more generalized than any other method and in principle may be used to analyze any polymer molecule, including proteins. The approach to the development of a solid-state nanopore device is novel in the use of nanofabrication, nanoelectronic components, and high-speed signal acquisition. A novel geometry of the solid-state nanopore (less than 5 nm in length and 5 nm in diameter) will enable 1 to 5 nucleotide resolution measurements. This means that maximum resolution will be improved at least 100-fold compared to biological ion-channel measurements. The solid-state nanopore sensor will be made to enable sequencing DNA at a much faster rate than presently possible without the need for extensive sample preparation procedures, such as enzymatic amplification and labeling reactions. It will analyze electronic properties of individual subunits of DNA or RNA, to obtain linear composition of each genetic polymer molecule.

BENEFITS

- **Permits fine control over pore dimensions**
- **Does not alter chemical composition of substrate**
- **Increased speed, sensitivity, and simplicity of operation**
- **Reproducible**
- **Entire pipette is composed of pure material (quartz glass)**



Rapid Polymer Sequencer: Technology Detail

Experimentation resulted in a solid-state nanopore made using nanofabrication techniques. The nanopore channel with a diameter and length of less than 5 nm is made in a silicon-based chip that has nanoelectrodes placed adjacent to the pore. High-speed electronic equipment with exceptional signal acquisition capabilities is used to analyze electronic properties of individual subunits of DNA or RNA, to obtain a linear composition of each genetic polymer molecule. The nanopore sensor is expected to have unmatched speed and sensitivity of DNA detection and sequencing, enabling personalized molecular medicine, revolutionary modification of agriculture and food industry, and decoding of ecosystem-wide genetic variation. The tremendous payoffs of such a nanopore sensor are twofold. Firstly, the complete DNA sequence information underlying the biodiversity of planet Earth will be within reach, thus enabling a complete understanding of the molecular basis of life. Secondly, such a robust sensor would enable the detection of life on other planets by detecting any information-encoding biopolymers, and would also apply to real-time, molecular astronaut health monitoring, and pathogen and environment monitoring systems.

APPLICATIONS

- **Medical and scientific applications**
- **Devices based on nanopores pipettes**
- **Pathogen and environment monitoring systems**
- **DNA or RNA detection and sequencing**
- **Agriculture and food industry**
- **Space research**

Patents

This technology has been patented (U.S. Patent 7,949,472 and 8,494,782).
Reference: ARC-15204-1 and ARC-15204-1DIV.

Licensing and Partnering Opportunities

NASA's Technology Transfer Program seeks to transfer this technology out of NASA's space program to benefit U.S. industry. NASA invites companies to inquire about licensing possibilities for this technology for commercial applications.

Learn More
For more information on this technology, and to discuss licensing and partnering opportunities, please contact:
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