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Designing Nanostructures at the Interface between Biomedical and Physical Systems

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A Micro System to Isolate, Sequence, and Identify DNA from a Small, Low-concentration Sample

Focus Group Description

Background

There is a constant demand to sense and analyze biological agents and components for purposes such as collection of genomic data, diagnosis of diseases, controlling of production processes, detection of the crime site, inspection and monitoring of environmental contamination, and warning for bioterror attacks. The most common bio agents range from DNA to proteins to viruses. Biosensing requirements are short response time, accurate and reliable reading, low equipment and operation costs, compact system size, low power consumption, etc. However, one of the most critical problems in biosensing is the sample quality. Many samples are too low in agent concentration and too small in volume. For example, many modern genomic and molecular biology assays involve selective amplification of specific regions of interest to extremely high concentration levels, followed by extraction and purification of the amplified products. Although there are several popular multiplication and isolation methods, such as PCR, in general, the reactions are slow and the equipment is cumbersome and costly.

The Problem

It is desirable to have a nano or micro system that can effectively multiply and isolate bio agents in a picoliter, low-concentration sample at a high rate with a simple operation procedure. It is further desirable that the sensing or analysis function is integrated into the nano or micro system so that the complete result is immediately available after the multiplication and isolation procedure. The following are some examples that need to be addressed:

- Methods that can multiply the picoliter-volume DNA concentration by several orders of magnitude.
- Nano or micro devices that can multiply the picoliter-volume DNA concentration by several orders of magnitude.
- Nano or micro sensors that can monitor the DNA concentration change in a picoliter volume.
- Nano or micro devices that can recover low concentration DNAs from a picoliter volume solution.
- Nano or micro devices that can separate different DNAs in a picoliter volume solution.
- Nano or micro devices that can identify different DNAs in a picoliter volume solution.
- Nano or micro systems that can simultaneously multiply, isolate, and identify DNAs in a picoliter volume solution.

Initial References

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