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Carbon Nanotube Nanopores

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Intellectual Property Status

Patent Pending

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Background

Nanopores are orifices of nanoscale diameter that connect two fluid reservoirs. At these dimensions, even a single molecule passing through the nanopore generates a detectable change in the flow of ionic current through the pore. As a result, nanopores can function as nanoscale Coulter counters, sensory devices that measure the effective change in electrical conductance across a small orifice as a particle passes through the orifice, to detect and analyze molecules.

Carbon nanotubes (CNTs), particularly single-walled (SW) CNTs, are obvious candidates for fabricating nanopore structures because CNTs do not require drilling and etching, like existing nanopore devices, and CNTs have ideally uniform physical and chemical interiors for such purposes. In fact, experimentation shows that nanopores composed of multi-walled (MW) CNTs provide measureable molecular translocation, and computer simulations suggest that SWCNTs will also provide measureable molecular translocation for tube diameters as small as approximately 1.5 nm. Still, the computational demands of simulating SWCNT devices require electrical field strengths much larger than are feasible in real device applications so it remains to be seen whether molecular translocation is actually measureable for realistic electrical fields and further, whether translocation will actually even occur.

Invention Description

Researchers at Arizona State University have developed SWCNT nanopores that successfully provide measureable molecular translocation. In fact, as a result of unexpected properties of the SWCNTs, these devices provide ionic current measurements far exceeding expected values, making the devices exceptional molecular sensors. Moreover, the inherent electrical properties of the SWCNTs allow the devices to function not only as nanopores but also as nanoelectrodes. Combining both these detection/analysis modes with recognition reagents tethered to the end of the tube provides three-way sensors, having the remarkable ability to detect even single molecules (e.g. DNA) passing through the devices.

Potential Applications

- **Sensory Detection and Analysis:** (e.g. explosives, chemical warfare agents, toxins, nucleic acids, etc.)

Benefits and Advantages

- **Provides Measureable Molecular Translocation** – SWCNT nanpores not only dramatically amplify the measureable ionic current passing through the tubes but also function as nanoelectrodes as a result of inherent electrical properties
- **Needle-in-a-Haystack Sensitivity** – able to measure even single molecules passing through the device to provide for unprecedented accuracy of detection
- **Allows Multiple Detection Modes** – redundancy offers both increased likelihood of successful detection and measurement selectivity/customization
- **Ability to Function as a Pre-Concentrator**
- **Improves Transport of Water** – enhanced by three-factors of magnitude
- **Excellent Manufacturability** – SWCNT nanopores require no drilling or etching and have advantageously uniform physical and chemical interiors