Nanoparticle Electrostatic Trap for Manipulation of Charged Particles

OTT ID# 1162

TECHNOLOGY

This invention provides a method of controlled and reversible trapping of charged micro- and nanoscale particles or single molecules (e.g. DNA) with an electrostatic device. This corral trap can confine single molecules in their native solution environment over controlled periods of time (e.g. hours) allowing for precise manipulation and observation. A prototype flow cell device for particle trapping is currently in development. With these traps, the inventors have successfully manipulated charged polystyrene microspheres with a 2μm diameter, nanospheres with a diameter of 21 nm, and single molecules of 800 nucleotide single-stranded DNA. This technology will revolutionize microscopy techniques for single molecule characterization, which until now have been thwarted by short observation dwell times in solution and the necessity for surface immobilization. The inventors have also developed an algorithm and software for automated trapping that is linked to images acquired by a microscope camera. Applications for molecular scale devices and new tools for biomedical diagnosis are also envisioned.

A method for manipulation and confinement of nanoscale objects and single molecules in solution has long remained a formidable task. Limitations of other trap systems such as the ABEL trap include limited resolution, trapping of only one particle at a time, constant monitoring of particle position, and a complex active feedback system. Optical tweezers are also used to immobilize microparticles but trapping of particles smaller than 100nm requires prohibitively high laser powers. Drs. Woehl and Carlson solve these trapping problems by providing a system that scales favorably with particle size, does not need an active feedback system, does not require continuous illumination or particle monitoring, and can trap multiple particles at the same time.

FEATURES/BENEFITS

- **Longer Observation** – Molecules can be observed for hours rather than minutes or seconds
- **Precise Control** – Trapping is achieved using a simple electrostatic setup
- **Reversible** – Trapping can be turned on and off at will
- **More Natural** – Can observe molecules in solution naturally without immobilization
- **Charge Selective** – Confinement is dictated by charge
- **Versatile** – Single molecules or multiple particles can be trapped simultaneously
- **Stable Trap** – No active feedback system required
- **Scalable** – Trap arrays can be integrated into microfluidic devices

INTELLECTUAL PROPERTY

A U.S. Utility patent application was filed in January 2011.
This technology is part of an active and ongoing research program and is seeking partners for development of the final product. A prototype flow cell device is currently under development and is expected to be completed by summer 2012. This technology is available for developmental research support/licensing under either exclusive or non-exclusive terms.

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MARKETS

This trapping technology will provide a great benefit to scientific researchers as well as new biomedical devices. Multiple university researchers across the country have shown an interest in or are currently testing the UWM system to trap biological samples including viruses, single molecules, single cells, and proteins (protein folding). This trapping system in a flow cell design could be utilized in diagnostic and biomedical applications such as DNA genotyping, DNA sequencing, forensic DNA analysis, and other DNA hybridization applications.

BCC research reported that microscopes are a multibillion-dollar industry that serve a vital role in life-sciences research, microelectronics, and advanced-materials science. Microscopy is particularly important to the expanding field of nanotechnology. The field of microscopy continues to evolve rapidly, as new requirements and imaging technologies are developed. Microscopy sales are predicted to reach $3.1 billion by 2014 with microscope accessories and supplies predicted to reach $513 million. BCC Research also reports that worldwide market for DNA sequencing products will grow to more than $3.3 billion by 2015. The largest markets for sequencing are life science research and drug discovery and development. New emerging applications include personal genomics and clinical diagnostics which are forecasted to reach $541 million by 2015 as compared to $15.5 million in 2010.

INVENTOR(S)

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Dr. Jorg Woehl is an Associate Professor in the Department of Chemistry and Biochemistry at the University of Wisconsin-Milwaukee. He obtained his Ph.D. in Physical Chemistry from the University of California at Riverside followed by Postdoctoral research at the University of Bordeaux in France which was conducted at the CPMOH (Center of Molecular, Optical and Hertzian Physics). Before coming to Milwaukee, Dr. Woehl was an Associate Professor at Joseph Fourier University in Grenoble, France in the Laboratory of Physical Spectrometry. His laboratory focuses on understanding how molecules use their innate electric fields to communicate with each other and how, in turn, electric fields can be utilized to trap and manipulate single molecules. Dr. Christine Carlson is a lecturer of chemistry at the University of Wisconsin – Rock County. She obtained her Ph.D. in Physical Chemistry from the University of Wisconsin-Milwaukee followed by Postdoctoral research also at the University of Wisconsin-Milwaukee.

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