# Enhanced particle trapping using carbon nanofiber mats

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**Abstract**

Dielectrophoresis (DEP) is a microfluidic technique that can trap and concentrate micro- and nanoparticles when subjected to a non-uniform electric field. DEP is dependent on field non-uniformities, as its force is proportional to the gradient of the electric field squared ($\nabla E^2$). One shortcoming of DEP is its low throughput as forces are focused at sharp features (i.e. electrode edges) which are typically planar and, thus, DEP forces are much weaker in the bulk. We seek to increase throughput by using a conductive nanofiber mat that will serve as a 3D mesh of sharp conductive features to distribute high DEP forces. The conductive nanofiber mat is created through electrospinning, thereby avoiding traditional microfabrication procedures. Carbon nanotubes are added to a solution of polyacrylonitrile dissolved in N, N-dimethyl formamide. This solution undergoes electrospinning and is subsequently heat treated to 800 $^{o}$C and undergoes pyrolysis. The carbon nanofibers have diameters between 300-800nm and an electrical conductivity between 2-5 S/cm. As a proof of concept, micro- and nanoparticles were trapped via DEP when an AC field was applied across a carbon nanofiber piece opposite of an indium tin oxide electrode. Positive (attractive) and negative (repulsive) DEP were observed at lower (kHz) and higher (MHz) frequencies, respectively. Scaling law analysis suggests that these conductive nanofibers create sufficient forces to trap nanoparticles and proteins. Future work will focus on high throughput trapping of nanoparticles. This material is based upon work supported by the National Science Foundation under Grant No. 2121008.

**Biography of Presenter**

Dr. Stuart J. Williams is a Professor in the Department of Mechanical Engineering at the University of Louisville. His lab studies various aspects of microfluidics with an emphasis on impedance spectroscopy, colloid characterization, and field-based manipulation of micro- and nanoparticles. Under the support of the NSF Graduate Research Fellowship Program, his Ph.D. (Purdue University, '09) used a combination of optical and electrical fields to dynamically pattern and trap microparticles. Current work in his lab includes building an electrokinetic microfluidic platform for studies on the ISS (NASA EPSCoR), designing an intraoperative device to measure bone density (NIH), creating specialized conductive nanofibers for enhanced filtration (NSF CMMI), and characterizing the dielectric properties of proteins and nanoparticles (NSF DBI). His lab website is microfluidics.louisville.edu.