Tunable Electrophoretic Separations Using a Scalable, Fabric-Based Platform*

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There is a rising need for low-cost and scalable platforms for sensitive medical diagnostic testing. Fabric weaving is a mature, scalable manufacturing technology and can be used as a platform to manufacture microfluidic diagnostic tests with controlled, tunable flow. Given its scalability, low manufacturing cost (<$0.25 per device) and potential for patterning multiplexed channel geometries, fabric is a viable platform for the development of analytical devices.

Here I present a fabric-based electrophoretic platform for the separation of protein analytes. The most generic form of electrophoresis separates charged biomolecules based on the speed with which they migrate under the influence of an electric field. I explored the ability to tune separation efficiencies and separation resolution for a range of analyte types (proteins, small molecules, and protein-nanoparticle conjugates) using the structure and surface properties of the fabric. A mathematical tuning factor was defined, showing that resolution increases with the packing density of the medium and decreases with its hydrophilicity. However, protein and peptide analytes often require hydrophilic, passivated surfaces. An optimal tuning ratio was therefore identified and tested for proteins and protein-nanoparticle conjugates, with potential applications in electrophoresis-mediated immunoassays for low-abundance clinical markers.

(*) This work was supervised by Dr. Shashi Murthy, Department of Chemical Engineering, Northeastern University.