There is an urgent need for low cost and multiplexed clinical testing for cancer screening, diagnostics and treatment monitoring. The diagnosis of cancer is often complex, and consists of identifying not one but a panel of markers to arrive at an accurate prognosis and to administer the right treatments. For instance, in breast cancers such as the breast invasive carcinomas, a set of markers including blood based Human Epidermal Growth Factor-2- Extracellular Domain (HER2-ECD), and tumor based Estrogen Receptor (ER) and Progesterone Receptor (PR) must be simultaneously assayed to determine tumor subtype, prognosis and course of treatment and to monitor the status of the patient during treatment.

While multiple laboratory approaches do exist to perform these diagnoses, a large subsection of the breast cancer afflicted population cannot reap its benefits due to a lack of access to medical infrastructure. Being able to multiplex breast cancer panels using microfluidics will not only alleviate this problem but also confer other benefits to the clinical test, such as minimizing sample loss in cases where the marker is present in concentrations several orders of magnitude lower than other sample components. An example of this is the low concentration of HER-2 relative to other blood proteins.

In the proposed project, a scalable and low cost manufacturing approach will be used to manufacture microfluidic devices. In prior exploratory work using this approach, we selected textile yarns and fibers with the appropriate wetting characteristics, coated them with assay reagents and assembled them in a single weaving step to pattern a network of microfluidic channels with tunable capillary flow, for the immunoassay of diagnostic markers from urine samples. For the current project, electrically conductive yarns were weaved in to
serve as electrodes in the woven fabric device, for use in the electrophoretic separation of a mixture of proteins. Electrophoretic separations are tremendously useful in cancer diagnostics and proteomics analyses as they allow us to simultaneously concentrate and fractionate specific tumor proteins in the clinical sample by virtue of the changes that occur in their physicochemical properties and expression levels during cancer progression.

Using the proposed platform, the near complete size-based separation of small molecule dye species with ~0.2 kDa difference in size was demonstrated, while complete separation was observed between two macromolecule species (proteins Albumin and IgG). Yarn and fabric based parameters, such as gradients in packing density, were investigated in order to tune the performance of the device in terms of its separation resolution and allow for the creation of distinct sample stacking (preconcentration) and sample separation regions in the device. We propose the electrophoresis mediated detection and assay of breast cancer marker proteins: HER2-Extracellular Domain from serum and ER and PR from biopsied tissue lysate, for applications in cancer treatment monitoring and tumor sub-typing. The ability to pattern a network of channels in weaved and knitted fabric will be used to design multiplexed separations.