A SILVER BUCKSHOT APPROACH

PATHOGEN DETECTION

Xuanhong Cheng focuses on challenges in point-of-care diagnostics.

Photo by Douglas Benedict
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A conversation with Xuanhong Cheng on her research is like talking to a multi-disciplinary artist. Cheng, an associate professor in the Departments of Bioengineering and Materials Science & Engineering at Lehigh whose work falls within the Diagnostics, Sensors and Devices research theme of the department, is developing new ways to detect pathogens in the field using portable devices. To do so, rather than looking for a silver bullet, she is taking what you might refer to as a silver buckshot approach. Using a creative combination of physical, chemical and optical methods, Cheng and her colleagues attack research obstacles from a variety of angles.

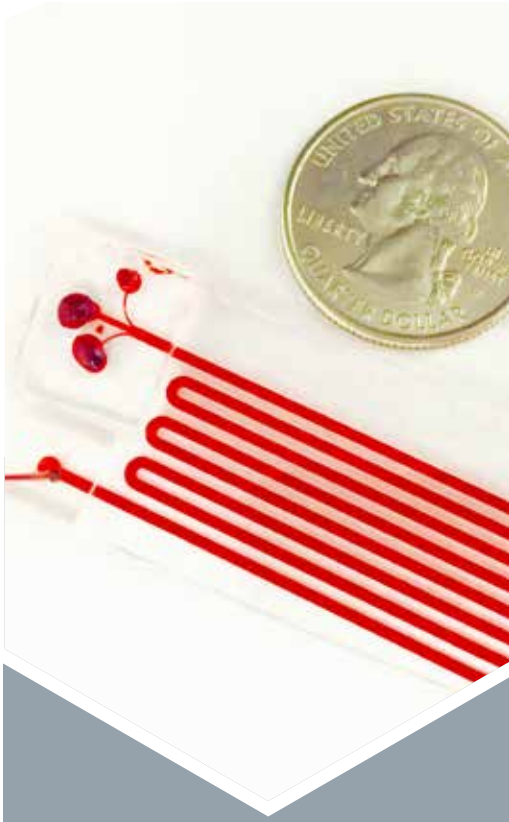
The demand for compact technology to analyze biological samples is urgent. For instance, determining viral load in HIV-positive patients is a routine monitoring task that is crucial to effective care, yet currently there is no point-of-care technology available. This often leads to delays in treatment or worse for patients in remote regions where HIV is most prevalent and even remote labs may be inaccessible.

One of Cheng's current projects is a virus enrichment procedure that concentrates viruses found in trace amounts to enable point-of-need detection. Current practices of virus enrichment require either large centrifuges or high pressure filters, both of which require significant training to operate. Cheng is on the way to designing a portable, microfluidic device that can enrich the virus from small samples using a combination of a temperature field and a microstructured plate that disturbs the flow of the fluid across the plate. "The physical obstruction of the microstructures interrupts laminar flow and creates a vortex," Cheng said. "When you couple that with an external temperature gradient you can drive the virus to one side of the channel, increasing their concentration." She is experimenting first with nanoparticles prior to testing the system with HIV. The apparatus is currently tabletop in scale, and able to process a few microliters of sample per minute. "All of this can be miniaturized, and we have verified that it works well with the nanoparticle surrogates," Cheng said. "We are now making sure that the virus will remain viable and not aggregate, so the downstream tasks necessary to analyze a sample won't be affected."

A second approach to point-of-care virus identification Cheng is exploring employs electrical sensors combined with a chemical filtering technique. A sample flows through a specially fabricated membrane designed to ensnare the virus. When electrical current is run across the membrane, the virus alters the current flow in proportion to its concentration.

In a third project, Cheng is using optical techniques to quantify virus presence in a sample. Cheng runs a sample across a gold plate gridded with a micropattern. When the virus binds to the surface, it alters the electron vibration of the metal, and the concentration of the virus is correlated with a shift in the wavelength of the light. Since the light falls within the visible spectrum, the binding is evident to the naked eye, permitting immediate viral detection.

"WE ARE CREATING DIFFERENT COMPONENTS, AND ADDRESSING CHALLENGES IN POINT-OF-NEED DIAGNOSTICS—FROM SAMPLE PREPARATION TO TARGET DETECTION—IN PARALLEL, " CHENG SAID. "HOPEFULLY, THEY WILL ALL MEET DOWN THE ROAD."
—Chris Quirk



Welcome
NEW BIOENGINEERING FACULTY AND STAFF

Nicole Fortoul completed her PhD in Chemical Engineering with Anand Jagota in May, 2017, and will continue as a postdoctoral fellow in Jagota's research group.