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Outward bound: scientists design high-throughput HIV test for the field

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Ariel Elghanayan

A fast, cheap, and efficient 'lab on a chip' device combines microfluidics and lens-free holographic imaging to make HIV testing more accessible in areas lacking resources.

Paradoxically, blood-based HIV diagnostics are most difficult to perform in locations where they are most needed—places where doctors, resources, and security are scarce. But now, researchers from the Biomedical Department at University of California, Davis (UC Davis) and the Department of Electrical Engineering at University of California, Los Angeles (UCLA) have developed a pocket-sized microfluidic device that reads big results from small drops of blood, without the use of a conventional microscope.

The research team has recently written about a novel miniscule device with both powerful diagnostic powers and cost-effective properties. The study hinges on two technological angles: cell capture using surface chemistry–based microfluidics, and cell analysis using lens-free holographic imaging.

"The paper is quite interesting in that we propose to monitor multiple immune parameters at the point of care and not simply focus on a single parameter," Alexander Revzin, associate professor of biomedical engineering at UC Davis, told *BioTechniques*. "This multiparametric analysis is enabled by both design of the surface and a novel imaging modality."

Lens-free imaging technology has been gaining media momentum over the past two years. The platform—which performs microscopy sans the traditional optical gear—has received awards from the likes of *Popular Mechanics* and *National Geographic*. "If you use the conventional method, you will be actually looking at a bulky microscope, which has not really changed much since the original invention," said Aydogan Ozcan, assistant professor of electrical engineering at UCLA. "Our contribution is to create tiny microscopes that could do imaging in cost-effective, compact, but at the same time lightweight interfaces that attach to a cell phone," he said. Ozcan is the founder of Mikroskia, a company that markets his patented, optics-free cell phone microscopes, which can photograph samples and send them digitally to a qualified source for analysis .

For HIV infection, the number of CD4 T-cells, the ratio of CD4 to CD8 T-cells, and the release of cytokines all serve as solid diagnostic signals. Monoclonal antibodies (Abs) specific for these cells and their cytokine excretions make up the antibody array that captures them during the microfluidic process. Traditionally, these numbers and ratios are achieved using an imaging process called flow cytometry, which is costly and requires highly trained personnel. The goal of this study was to find a way of quantifying the results of the test more easily and cheaply, without sacrificing a high-throughput, multiparametric analysis.

The chemical surface structure of the devices test strip incorporates antibody microarrays with microfluidics, blood incubation, on-chip mitogenic activation and subsequent entrapment of the T-cells CD4 and CD8, and three cytokines TNF-a, IFN-y, and IL-2. An optoelectronic sensor array picks up the shadows cast by each of these cells and cytokines, which are then translated into holograms for high-throughput enumeration and simultaneous quantification of binding to the Ab microarrays. "The polymer-coated test strips with embedded antibody spots are envisioned as disposables—à la glucose tests—while the imaging and fluid handling components will be combined in a reusable meter," said Revzin.

Microfluidics and lens-free microscopy address a shift in the need for medical technology that can be used in the field to diagnose a variety of diseases, or assess environmental factors such as water quality. Microfluidics can capture cells like magic, and lens-free imaging provides a simple translation of Ab microarray images into meaningful results. "For this particular application of HIV patient monitoring, you need to combine those technologies," said Ozcan.

The paper, "Lensfree holographic imaging of antibody microarrays for high-throughput detection of leukocyte numbers and function," was published April 1, 2010 in *Analytical Chemistry*.

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