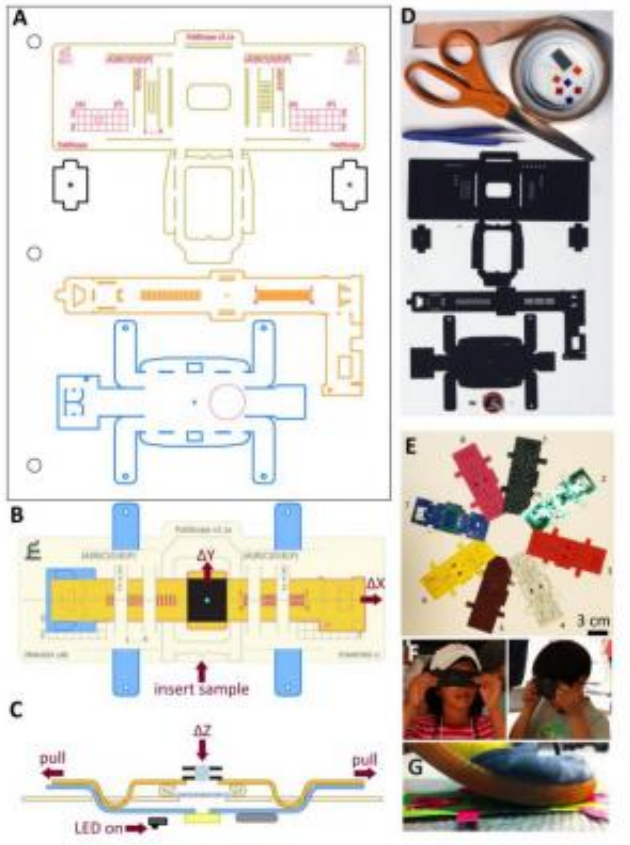
DIY microscope holds promise in battles against disease

March 10 2014, by Nancy Owano



Foldscope design, components and usage. (A) CAD layout of Foldscope paper components on an A4 sheet. (B) Schematic of an assembled Foldscope illustrating panning, and (C) cross-sectional view illustrating flexure-based focusing. (D) Foldscope components and tools used in the assembly, including Foldscope paper components, ball lens, button-cell battery, surface-mounted LED, switch, copper tape and polymeric filters. (E) Different modalities assembled from colored paper stock. (F) Novice users demonstrating the technique for using the Foldscope. (G) Demonstration of the field-rugged design,

such as stomping under foot. Credit: arXiv:1403.1211 [physics.optics]

(Phys.org) —Did they say fifty cents? That is how much researchers say it would cost, and maybe less, to make a microscope that you print on a piece of paper and then add some components and assemble in minutes, not hours. Stanford University's Manu Prakash, an assistant professor of bioengineering, and colleagues have been working on merging principles of optical design with origami. The result is something in the order of origami optics, or you might call it by the title of the team's paper detailing their work, "Foldscope: Origami-based paper microscope," submitted earlier this month on arXiv.

Prakash had presented the idea in a 2012 TED talk, and now the research paper, explaining the team's Foldscope, was authored by James Cybulski, James Clements, and Prakash, representing Stanford's departments of Mechanical Engineering and Bioengineering. The authors wrote that they are presenting "ultra-low cost brightfield, darkfield, and fluorescence microscopes designed for rugged applications in science and education." The end result is a light, rugged instrument with imaging capabilities for use as portable microscopes.

One motivating driver to create their Foldscope was as a low-cost medical screening tool in developing countries where medical researchers study organisms to guide treatment and practitioners cope with such diseases such as malaria. As *Gizmodo* observed, "A cheap, long-lasting, easily transported microscope means quicker diagnosis and treatment in places where doctors can't count on a fully-stocked laboratory." Another key benefit would be augmenting science education to children in developing and developed countries.

"By removing cost barriers, Foldscope provides new opportunities for a

vast user base, said the Stanford team. "Many children around the world have never used a microscope, even in developed countries like the United States. A universal program providing 'a microscope for every child' could foster deep interest in science at an early age." One challenge in doing so has been availability of tools previously cost-prohibitive.

Prakash, who did his master's and PhD in applied physics at MIT before founding the Prakash Lab at Stanford, said their challenge was to come up with the best possible instrument almost for free. What emerged from the challenge were "little microscopes built out of paper, tape and glue." Prakash said "They are as good as many research microscopes that you can buy." He said the cost for the effort came down to 55 cents to 45 cents, and that there were many more iterations to come.

Gizmodo's simple description of what the Foldscope is all about is especially useful: Outlines of the parts are printed on a sheet of cardboard with the pieces cut and folded according to color coding. With light from an LED, watch battery that lasts 50 hours, and tiny lens, the microscope is ready in minutes.

As the paper explained, the Foldscope is assembled via folding. The other primary components include a spherical ball lens (or other micro-lenses), lens-holder apertures, an LED with diffuser or condenser lens, a battery, and an electrical switch. In their paper, they said the LEDs they used in build their Foldscopes included the Avago HSMW-CL25 (now replaced by P/N Avago ASMT CW40) white LED for brightfield Foldscopes, and the Kingbright APTD1608QBC/D blue LED for fluorescence Foldscopes. The electrical slider switch was purchased from AliExpress.com ("Off/On MINI SMD Switch" from Product ID: 665019103). The power sources included Duracell 3V CR2032 button cells, Sanyo 3V CR2016 button cells (Sanyo CR2016-TT1B #8565 from Batteriesandbutter.com), and a GW Instek DC power supply (Model

GPD-3303D). Button cells were used with no resistors for Foldscopes.

More information: Foldscope: Origami-based paper microscope, arXiv:1403.1211 [physics.optics] arxiv.org/abs/1403.1211

Abstract

Here we describe an ultra-low-cost origami-based approach for large-scale manufacturing of microscopes, specifically demonstrating brightfield, darkfield, and fluorescence microscopes. Merging principles of optical design with origami enables high-volume fabrication of microscopes from 2D media. Flexure mechanisms created via folding enable a flat compact design. Structural loops in folded paper provide kinematic constraints as a means for passive self-alignment. This light, rugged instrument can survive harsh field conditions while providing a diversity of imaging capabilities, thus serving wide-ranging applications for cost-effective, portable microscopes in science and education.