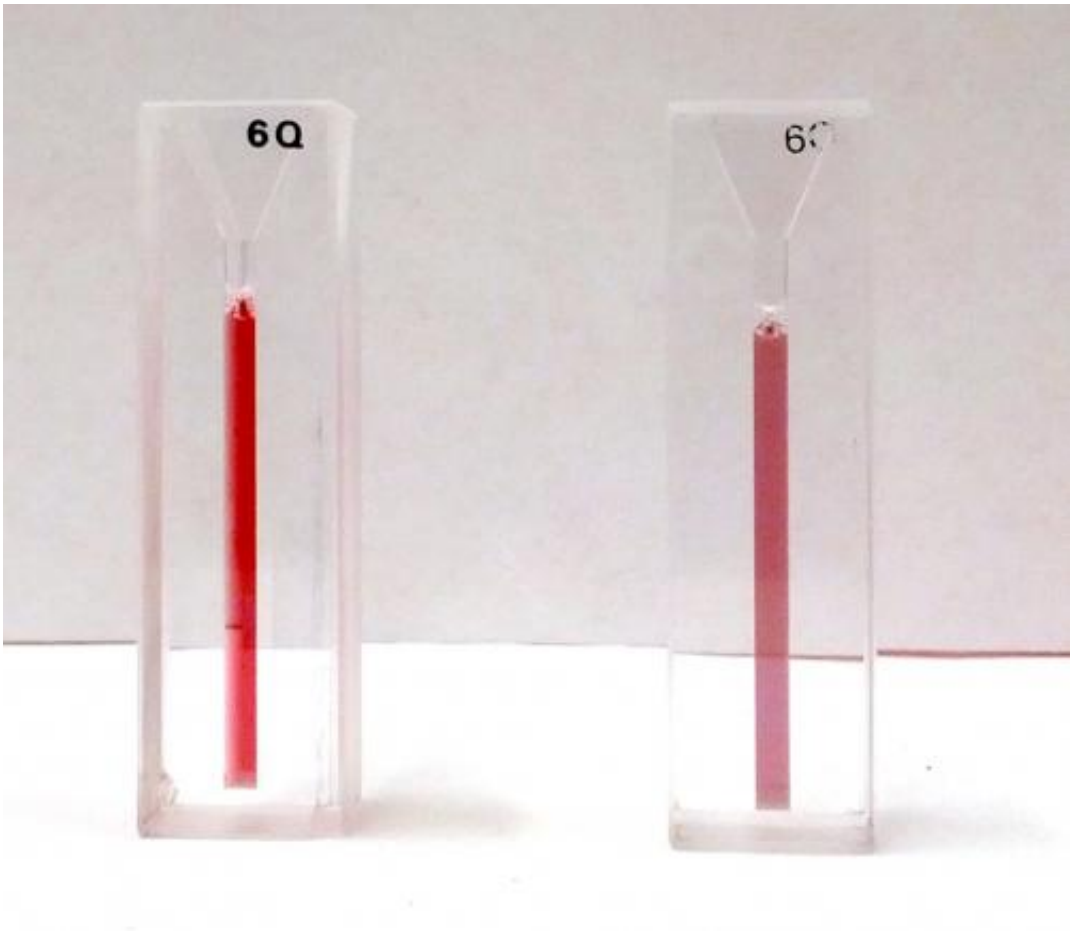
Detecting disease with a smartphone accessory

June 4 2013



Gold nanoparticle conjugates change from bright red to dull purple with the addition of target viral DNA. Credit: Matthew Mancuso.

As antiretroviral drugs that treat HIV have become more commonplace,

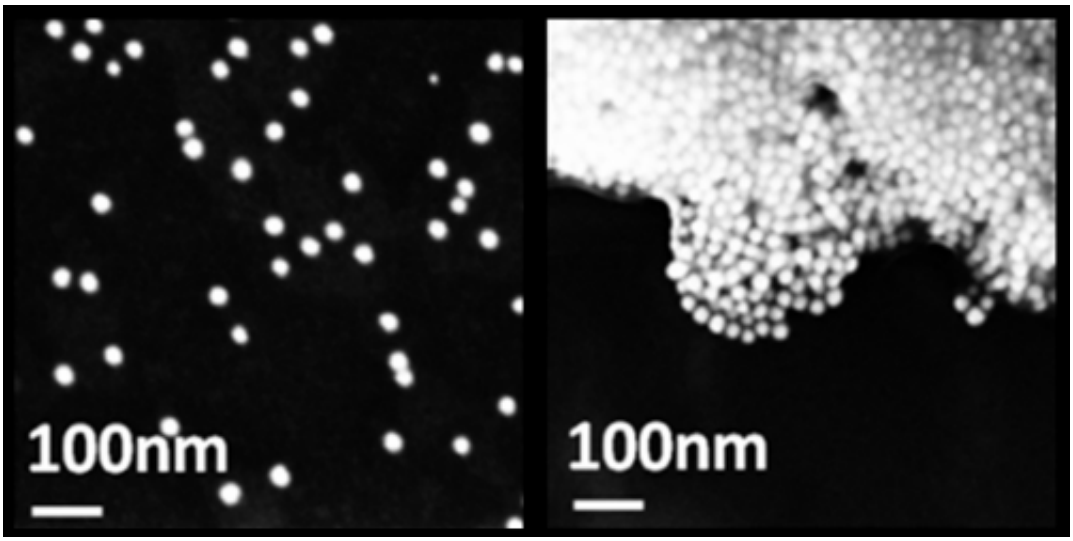
the incidence of Kaposi's sarcoma, a type of cancer linked to AIDS, has decreased in the United States. The disease, however, remains prevalent in sub-Saharan Africa, where poor access to medical care and lab tests only compound the problem. Now, Cornell University engineers have created a new smartphone-based system, consisting of a plug-in optical accessory and disposable microfluidic chips, for in-the-field detection of the herpes virus that causes Kaposi's.

"The accessory provides an ultraportable way to determine whether or not viral DNA is present in a sample," says mechanical engineer David Erickson, who developed the technique along with his graduate student, biomedical engineer Matthew Mancuso. The technique could also be adapted for use in detecting a range of other conditions, from E. coli infections to hepatitis. Mancuso will describe the work at the Conference on Lasers and Electro Optics (CLEO: 2013), taking place June 9-14 in San Jose, Calif.

Unlike other methods that use smartphones for diagnostic testing, this new system is chemically based and does not use the phone's built-in camera. Instead, gold nanoparticles are combined (or "conjugated") with short DNA snippets that bind to Kaposi's DNA sequences, and a solution with the combined particles is added to a microfluidic chip. In the presence of viral DNA, the particles clump together, which affects the transmission of light through the solution. This causes a color change that can be measured with an optical sensor connected to a smartphone via a micro-USB port. When little or no Kaposi's virus DNA is present, the nanoparticle solution is a bright red; at higher concentrations, the solution turns a duller purple, providing a quick method to quantify the amount of Kaposi's DNA.

The main advantage of the system compared to previous Kaposi's detection methods is that users can diagnose the condition with little training. "Expert knowledge is required for almost every other means of

detecting Kaposi's sarcoma," Mancuso says. "This system doesn't require that level of expertise."

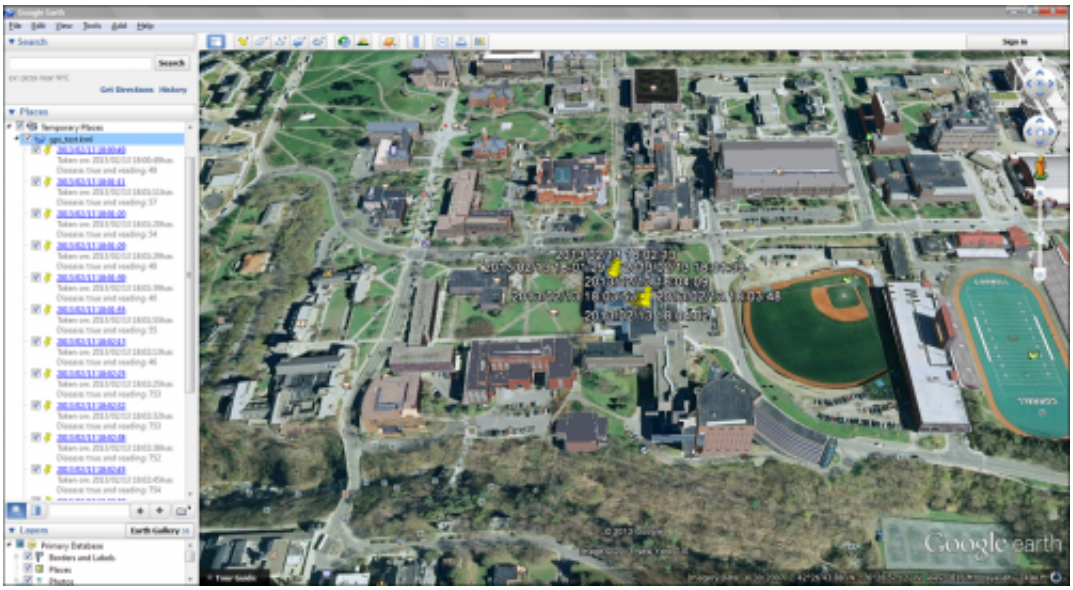


The addition of target viral DNA causes the nanoparticles to form aggregate "clumps," which leads to a change in their color. Credit: Matthew Mancuso.

Erickson and Mancuso are now collaborating with experts on Kaposi's at New York City's Weill Cornell Medical College to create a portable system for collecting, testing, and diagnosing samples that could be available for use in the developing world by next year. The team's start-up company, vitaMe Technologies, is commercializing similar smartphone diagnostic technologies for domestic use.

Detecting Kaposi's sarcoma is not the only goal, Mancuso says. "Nanoparticle assays similar to the one used in our work can target DNA from many different diseases," such as methicillin-resistant Staphylococcus aureus (MRSA), a bacterium responsible for several difficult-to-treat infections in humans, and syphilis. The smartphone reader could also work with other color-changing reactions, such as the

popular enzyme-linked immunosorbent assays (ELISA), a common tool in medicine to test for HIV, hepatitis, food allergens, and E. coli. The lab also has created smartphone accessories for use with the color-changing strips in pH and urine assays. "These accessories could form the basis of a simple, at-home, personal biofluid health monitor," Mancuso says.



Maps generated using Smartphone-enabled GPS tagging of diagnostic results could enable health professionals to track the spread of infectious disease in the future. Credit: Credit: Matthew Mancuso.

CLEO: 2013 presentation AM3M.2. "Smartphone Based Optical Detection of Kaposi's Sarcoma Associated Herpesvirus DNA" by David Erickson is at 2 p.m. on Monday, June 10 at the Marriott San Jose.

Provided by Optical Society of America