

## DIAGNOSIS ON A CHIP

by David Pescovitz

Beginning next summer, a tiny bio-chip developed at UC Berkeley will help researchers in Nicaragua understand and screen for a tropical disease that incapacitates as many as 100 million people each year. Melding microbiology with microcircuitry, the 2 mm square ImmunoSensor provides a quick, inexpensive test for the dengue virus, commonly known as "break-bone fever," even when the nearest clinical laboratory may be hundreds of miles away.

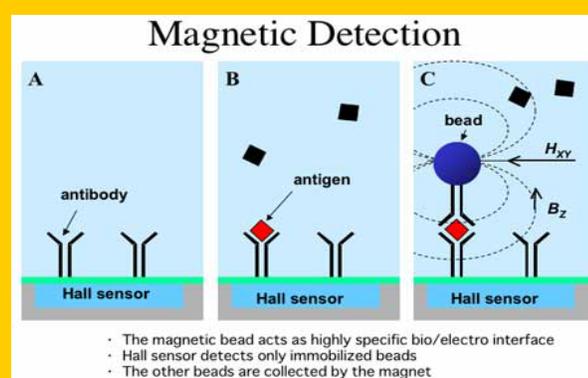
"In the third world, there aren't very many specialized labs that can test these blood samples," says co-inventor Bernhard E. Boser, a professor in the Department of Electrical Engineering and Berkeley Sensor & Actuator Center (BSAC). "Many regions don't even have the quality of water you need to do traditional tests."

The solution was to put the laboratory right on the chip, at a cost of less than \$1 each. In fact, right now Boser and his collaborators—Molecular and Cell Biology Professor P. Robert Beatty, Professor Eva Harris in the School of Public Health, and their graduate students—are readying 1,000 of the ImmunoSensors to ship to Nicaragua in time for dengue season. Spread by mosquito, the dengue virus causes brutal headaches, intense fever, rashes, and, in infants, the risk of death. The field study is being coordinated by the Sustainable Sciences Institute (SSI), a non-profit

organization focused on addressing local problems related to infectious diseases in developing nations.



Prof. Boser holds an ImmunoSensor chip. The chips are donated by National Semiconductor and then modified in UCB's Microfabrication Lab.  
David Pescovitz photo



This illustration depicts the how antigens bind to both the magnetic beads and the magnetic sensors, called Hall sensors, on the surface of the chip.

body that bonds to the antigen indicative of a particular disease.

"If the antigens are in the blood sample, the beads grab onto them," Boser explains. Then, gravity causes the beads to fall onto a tiny array of 256 magnetic sensors at the bottom of the well. The sensor array is also coated with the particular antibody that binds to the disease antigen. After the beads settle, a magnetic field is applied. Beads that aren't now immobilized by the antigen on the surface of the chip are pulled away from the sensor array.

"We call it magnetic washing," Boser says.

Finally, the sensor array is activated. The electrical resistance of the array corresponds to the number of beads that are stuck on the sensors thanks to the antibody-antigen bond. The detection of immobilized beads mean the particular antigen is present and that the subject whose blood was tested most likely is infected with the dengue virus. The entire process takes little more than a minute.

Currently, the chip plugs into a conventional laptop computer running the ImmunoSensor software that provides the data to the person administering the test. The next step, Boser says, is to make the chips wireless and port the software over to a palm computing platform, even further increasing their portability. Meanwhile, Beatty is working to develop an HIV test that would also run on the ImmunoSensor platform.

"You could imagine buckets of these chips, all coated with different antibodies so we can not only detect on-the-spot when someone is ill, but also find out exactly what illness they have," Boser says.



Each ImmunoSensor chip is fabricated using bulk processes similar to the way integrated circuits are manufactured.

VOLUME 3

ISSUE 8

OCTOBER 2003

Editor,  
Director of Public Affairs:  
Teresa Moore

Writer, Researcher:  
David Pescovitz

Web Manager:  
Michele Foley

Lab Notes  
is published  
online by the  
Public Affairs Office  
of the UC Berkeley  
College of Engineering.

The Lab Notes mission  
is to illuminate  
groundbreaking research  
underway today at the  
College of Engineering  
that will dramatically  
change our lives  
tomorrow.

© 2003 UC Regents.  
Updated 9/29/03.

