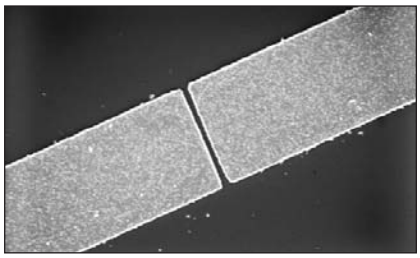
Rapid Identification Technique for Bacteria Makes Some Noise

Rapid and sensitive identification of bacteria is crucial in clinical, agricultural, biodefense and other applications. Currently available technologies for the identification of bacteria or viruses, such as culturing and polymerase chain reaction (PCR), have drawbacks such as long time to bacteria isolation, expensive instrumentation or poor selectivity between living and dead bacteria. Now, a team of scientists from Texas A&M Univ.'s (TAMU; College Station; www.tamu.edu) electrical engineering, biochemistry and biophysics departments have developed a break through technology called SEnsing of Phage-Triggered Ion Cascade (Septic) that detects living bacteria within several minutes, without false response, and with unparalleled specificity."Since a type of phage will infect only a certain type of bacterium, the voltage fluctuations and power spectrum serve as the calling card for a pathogen," says Mosong Cheng, electrical engineering professor at TAMU. The sensitivity is believed to be on the single bacterium level.

When the phage drills a hole in the membrane of the host cell and injects DNA into it, massive, transitory ion (*e.g.*, K^+) leakage from the host occurs within seconds. If bacteriophage infects a bacterium, the DNA will replicate phages inside the bacterium. Several minutes after the initial penetration, the host cell bursts and the progeny phages (typically 100–300 of them) are released. The nanowell uses two 4-mm wide titanium electrodes spaced 150 nm apart on a $LiNbO_3$ biochip to probe the leakage. The voltage signal is amplified and analyzed.

Mixing phages with resistant bacteria (no infection) resulted in the voltage due to background noise to be no more than 0.1 μV. However, minutes after mixing phage with sensitive bacteria (infection occurs), the scientists observed fluctuations of about 1–10 μV with a completely different power spectrum. This noise is believed to be caused by the Brownian motion of the released ions and the charged bacteria, and can be used for pathogenic detection.



The Septic technique uses a nanoprobe to detect voltage fluctuations caused by the ion efflux from a bacterium when it is infected by bacteriophage. Image dia. = 13 μm.

The cost of the biochip (around $20), amplifier and spectrum analyzer used in Cheng's lab is a collective $50,000. However, he quickly points out that the amplifier may be easily integrated with the chip and a handheld PC used in place of the spectrum analyzer, to create a portable bio-lab that costs about $600. Technologies employing a microscope cost at least $20,000 and PCR systems costs at least 10 times more.