Nano World: Technique peers under surfaces

October 18 2005

Scientists can now spot microscopic defects hidden inside any material and parasites within cells using a new imaging method that can peer through surfaces to see buried objects nanometers in size, experts told UPI's Nano World.

The most powerful microscopy techniques currently available mostly are sensitive only to surface features or to details located right below the surface. Peering any deeper with these methods requires damaging the surface, explained materials scientist Gajendra Shekhawat at Northwestern University in Evanston, Ill.

Shekhawat and his colleague Vinayak Dravid have developed an imaging technique capable of resolving details 20 nanometers in size a micron below surfaces. Using their method, dubbed scanning near-field ultrasound holography, the researchers spotted defects in microelectronic structures and watched malaria parasites inside living red blood cells in real time. Shekhawat and Dravid report their findings in the Oct. 7 issue of the journal Science.

"We think this can have a great societal impact by studying the biomechanics of living cells, tissues and membranes. And we think this can have tremendous impact on the semiconductor industry to spot defects that can damage circuits, which the industry has to detect by damaging wafers," Shekhawat said. "And this is a pretty cheap technology that can fit on any scanning probe microscopy platform."

The key elements of the device are piezoelectric crystals, which vibrate under the influence of an alternating current. The researchers place a sample they wish to scan between a crystal and a probe fitted with piezoelectric crystals that make them vibrate at roughly 30 or 40 million times per second. These oscillators each vibrate at slightly different frequencies, and the interference between them creates an acoustic wave across the sample surface. Any features hidden within the sample alter this wave. The probe monitors any change in the wave's frequency, and when these perturbations are properly deciphered, they reveal the buried features in high detail.

The researchers hope to incorporate oscillators that vibrate at up to a billion times a second by the end of next year, which should make the imaging technique capable of seeing 1-nanometer-sized details up to 3 microns below the surface, Shekhawat said. Other future directions include having many probes operate in parallel on a sample to enhance the speed of scanning for real-time inspection of defects in the semiconductor industry. They also want to develop their method so it can three-dimensionally scan a sample to, for instance, monitor the effect of toxins in living cells or the biomechanics of cells and tissues.

This new technique could be of benefit to the general public "through the ability to develop integrated circuits that are more reliable," said metrologist Alain Diebold, a senior fellow at semiconductor industry leader consortium SEMATECH in Austin. He hoped research groups nationwide begin adopting this method soon.