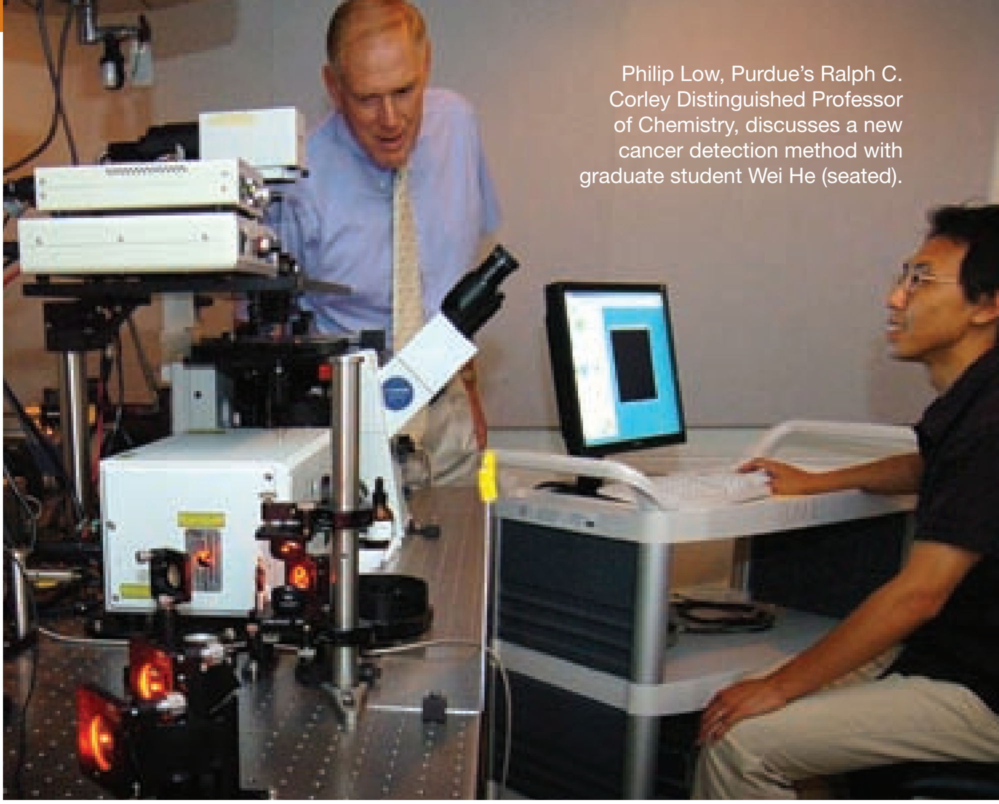
Surface-Vein Scans Track Cancer Spread



Philip Low, Purdue's Ralph C. Corley Distinguished Professor of Chemistry, discusses a new cancer detection method with graduate student Wei He (seated).

Purdue News Service photo/David Umberger

"Did you get all the cancer out?" Physicians face that question every time they operate to remove a tumor. New research involving a laser-imaging technique could help answer it.

A team from Purdue University and the Mayo Clinic is developing technology to scan cancer patients for tumor cells circulating in their bloodstream (Proc. Acad. Natl. Sci. USA **104**, 11760). These cells are at the beginning stage of metastasis, and their source is a tumor somewhere in the body, said Philip S. Low, a Purdue chemistry professor involved in the research.

A tumor will shed up to 1 million cells per gram of mass every day. Most of these bad cells will fail to colonize an adjacent organ; the patient's spleen, liver or macrophages will remove them. But their presence indicates that the patient is not completely disease-free.

Surgeons typically remove every tumor found by imaging, but in the case of ovarian cancer, for example, there's no way to know whether all the mass was eliminated. "In general, the recommendation is that you'd better take the chemo just to make sure," Low said.

After chemotherapy, roughly half of all ovarian cancer patients will still have the disease. However, for the first year or so after treatment, the protein markers for ovarian, prostate and other hard-to-stop cancers are not detectable in patients' bloodstreams. If the marker level rises 12 to 14 months later, it's usually too late, according to Low.

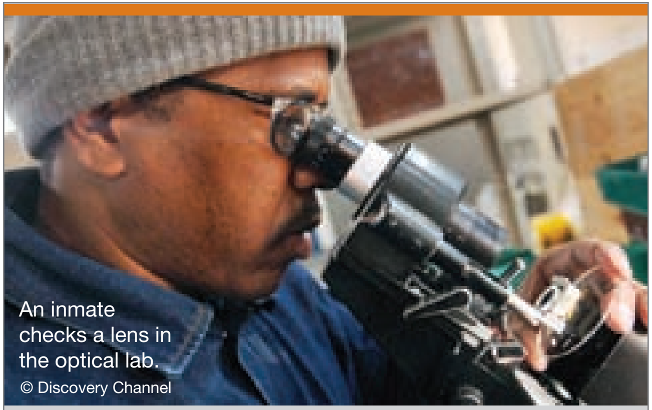
Low's group found a way to shine an infrared laser on surface veins and look into a much larger volume of blood than can be drawn into a phlebotomist's syringe. Folic acid binds to most tumor cells but not normal blood cells, so the researchers linked a fluorescent dye to folic acid and injected the substance into the bloodstream.

When the objective of a multiphoton fluorescence microscope is placed against a surface vein like those in a patient's wrist, scientists can see the moving bright spots that indicate circulating tumor cells. "In a normal patient you can sit for 45 minutes and not see a single [tumor] cell, but in a cancer patient they come by every few seconds," Low said.

The imaging can run for a half hour or more, and, during that time, a large percentage of the patient's total blood volume will pass by the detector.

The Purdue team has used both multiphoton and confocal methods of imaging in its early experimental phase. Multiphoton microscopy yields a higher signal-to-noise ratio than confocal microscopy and permits cell counts in deeper blood vessels. However, it is also much more expensive.

— Patricia Daukantas



An inmate checks a lens in the optical lab.
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Did You Know?

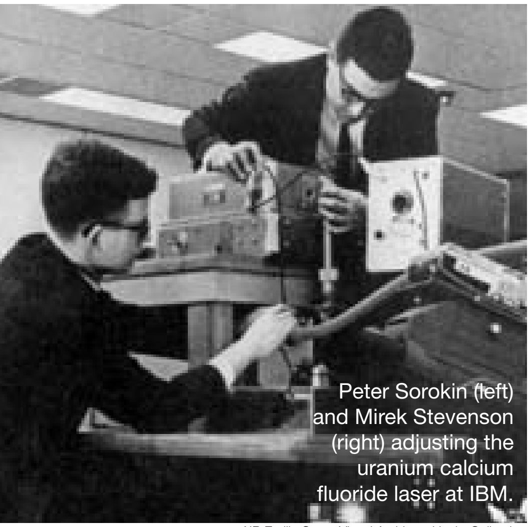
The California Prison Industry Authority (PIA) operates an optical lab in Solano State Prison. Inmates in the Vacaville, Calif., medium-security facility learn how to make prescription eyeglasses and safety eyewear for other inmates, state hospital patients and state and local government employees who need to protect their eyes on the job. The California penal code prohibits PIA from selling its products to the public, but the Solano lab still makes 83,000 pairs of eyewear annually. With enough study, an inmate can even earn national certification as an optician.

Laser Pioneer's Solution to Interstellar Puzzler

Peter P. Sorokin worked on some of the first lasers in the early 1960s. More recently, he's been studying a long-standing astronomical mystery that may also involve coherent light.

Sorokin has been eyeing the so-called diffuse interstellar bands (DIBs), a series of broad absorption features in the spectra of stars within our galaxy. First noticed in the 1920s, astronomers have yet to come up with a definitive explanation of the phenomenon, though many say that complex interstellar organic molecules, such as polycyclic aromatic hydrocarbons (PAHs), create these bands when starlight undergoes linear scattering or linear absorption.

With a background in nonlinear optics from a career at IBM's Thomas J. Watson Research Laboratories, Sorokin and his colleague James Glownia (now at Los Alamos National Laboratory) have been studying OB stars, which are the largest and hottest stars on the main sequence of stellar evolution. Such stars have a surface temperature of at least 20,000 K, compared with 6,000 K for the sun.



Peter Sorokin (left) and Mirek Stevenson (right) adjusting the uranium calcium fluoride laser at IBM.

AIP Emilio Segre Visual Archives, Hecht Collection

At September's Frontiers in Optics conference in San Jose, Calif., Sorokin and Glownia presented their study of the 2175-Å extinction band as a postdeadline paper (PDP-B4). This DIB in the spectrum of hot main-sequence stars was first noticed 42 years ago. "It's a true mystery in astronomy," Sorokin said.

According to Sorokin, stimulated Rayleigh scattering, occurring in molecular hydrogen clouds that may surround these hot stars, would generate coherent light. The H_2 clouds then absorb some of that light via the nonlinear process of two-photon absorption.

After looking at the ultraviolet spectra of 215 OB stars, the duo found a correlation between the strength of the 2175-Å band in a given star and the extent to which the molecular hydrogen is nonlinearly photoexcited via stimulated Rayleigh scattering.

Sorokin, a fellow of both IBM and OSA, won the Society's 1978 R.W. Wood Prize for an outstanding discovery or invention in optics. He and Mirek Stevenson developed the second-ever working laser (uranium-doped calcium fluoride) in 1960, just months after Theodore Maiman's ruby laser. Sorokin also co-discovered laser action in organic dyes in 1966 and pioneered the laser-pumped dye laser in 1969.

Sorokin and Glownia published a detailed exposition of their DIBs theory in 1996 (Astrophys. J. **473**, 900). In a related news article in *Science*, however, some astronomers questioned whether the illuminating stars would produce enough intense coherent light to stimulate the two-photon absorption process. Sorokin and Glownia countered that the PAH hypothesis would require the even distribution of hundreds of types of carbon molecules through the galaxy.

Several noted journals have rejected the pair's most recent papers, Sorokin told the FiO postdeadline gathering. He added: "It's obvious they don't understand nonlinear optics."

[Patricia Daukantas (pdauka@osa.org) is the senior writer/editor of *Optics & Photonics News*.]