PHYSICS UPDATE

MICROFLUIDIC FLOWS driven by thermal gradients. Microfluidics is to the mixing of fluids what integrated circuits are to the processing of electrical signals: Transactions occur quickly, controllably, and in a very small region of space. A common technique involves excavating nano-sized channels in a substrate and then propelling tiny fluid volumes around the system of aqueducts with electric fields. Such systems allow for turbulence-free mixing and analysis of small samples of, for example, blood or DNA. At the November 1999 meeting of the American Physical Society's division of fluid dynamics, Princeton University professor Sandra Troian reported moving tiny parallel rivulets along the surface of a silicon wafer using mild temperature gradients rather than electric fields. In such a system, the liquid experiences a variable liquid surface tension, which causes it to seek out a relatively colder region. The pathways were "drawn" by chemical lithography or UV ablation of a monolayer. With thermocapillary microfluidics, high electric fields and the precision carving of channels are not necessary, and everything happens on an open planar surface, which could simplify the fabrication of "labs-on-a-chip." (D. E. Kataoka, S. M. Troian, *Nature* **402**, 794, 1999.) —PFS

ULTRASOUND IMAGING without physical contact between device and patient has been achieved, providing a potential solution to a pressing medical need—determining the depth and severity of burns in a convenient, accurate, and pain-free fashion. Currently, physicians usually diagnose burns by visual inspection, but that cannot provide direct information on whether there is damage to underlying blood vessels, a condition that requires surgery. Technologies such as magnetic resonance imaging or conventional ultrasound are too slow, too cumbersome, or too painful if they require direct contact with the burn area. In particular, conventional US requires direct contact because of the great impedance mismatch between air and the transducer; without contact, most of the sound would bounce right back into the device without having penetrated any tissue. At the November 1999 meeting of the Acoustical Society of America, Joie Jones (University of California, Irvine) reported passing ultrasound through a multilayered material, with each succeeding layer having an impedance value closer to that of air; the technique is similar to using antireflective coatings on optical systems. He and his colleagues were then able to image burns by holding their device about 5 cm away from the skin for about a minute or so. Having tested this device on over 100 patients, the researchers plan to begin larger clinical studies and develop a device that can take images in real time. (A preprint is available from Jones.) —BPS

LASER LIGHT IN, STREAMS OF PROTONS OUT. At the November 1999 meeting of the American Physical Society's division of plasma physics, three groups independently announced their ability to generate intense streams of energetic ions by shining ultrashort laser pulses on tiny spots of solid foil targets. Researchers from Lawrence Livermore National Laboratory reported using a single pulse of light from the Petawatt laser to generate 3×10^{13} protons with energies of up to 50 MeV. A group from the University of Michigan reported using a tabletop terawatt ("T-cubed") laser, having one-thousandth the power of the Petawatt, to produce 10^9 protons, confined to an exit cone of about 40°, and having energies of up to about 1.5 MeV. Lastly, researchers from Imperial College (University of London, UK) revealed that, using the Vulcan laser at the Rutherford Appleton Laboratory, they had accelerated lead ions up to 420 MeV and protons up to 30 MeV. The physics is similar in all three demonstrations: The laser pulse drives electrons to the back of the target, whereupon the ensuing electric field accelerates ions out the back. Such laser ion acceleration might someday be used to produce ions for cancer therapy and electronics manufacturing. —BPS

NONTHERMAL MELTING of germanium has been observed. In general, a solid becomes a liquid when its thermal energy exceeds its atomic binding energy—the atoms rattle around so much that they break free of their lattice. But one can envision breaking all the bonds between atoms in a cold solid so quickly that the atoms will never have a chance to move first. In fact, there has been indirect evidence for that very process occurring in germanium when exposed to an intense laser pulse. Some subpicosecond effects looked like melting, which normally would take tens to hundreds of picoseconds. Now, a group of researchers led by Craig Siders (University of California, San Diego) has used ultrafast x-ray diffraction to follow the structural changes in laser-irradiated germanium in real time. They found that a thin surface layer homogeneously lost all its crystalline order within a few picoseconds, a clear indication of nonthermal melting. That disorder then propagated by thermal melting, both outward along the surface and into the bulk. For more on ultrafast chemistry, see our story on last year's Nobel Prize (December 1999, page 19). (C. W. Siders *et al.*, *Science* **286**, 1340, 1999.) —SGB