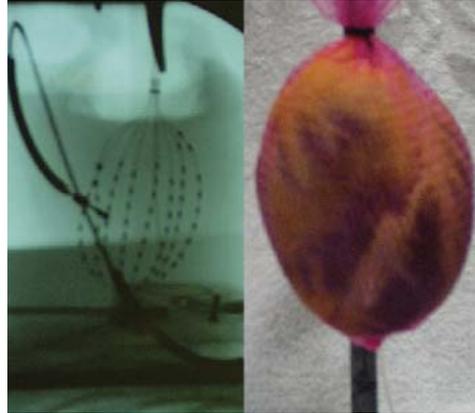


SHOCKING GENES

GENE THERAPY HOLDS PROMISE for treating diseases from cystic fibrosis to diabetes. But safely and effectively delivering genes to the cells that need them has been the field's biggest obstacle. Luyi Sen, a cardiologist at the University of California, Los Angeles's David Geffen Medical School, has a technique that could help: she uses small electric shocks to "push" the genes into cells. Scientists have long employed electric shocks to transfer genes into cells in research labs, but the voltages used would damage whole organs. Sen has lowered those voltages by placing electrodes in contact with a patient's tissues. She arranges 32 to 128 electrodes in a "basket" on a catheter or endoscope and threads the tube through blood vessels into the interior of an organ, where the basket is expanded. Therapeutic genes in solution are fed through another vessel, and tiny electric jolts induce cells to take up the genes. In tests on rabbit hearts, genes have been transferred at up to 75 percent efficiency. Today's most popular gene delivery method, viruses made noninfectious, has top rates of only 70 percent and can cause dangerous immune reactions. Several firms have expressed interest in manufacturing Sen's devices.



Electrodes inside (left) and outside a human heart.

DATA REMEDY

One PC at work, another at home, a laptop on the plane, and a personal digital assistant in the taxicab: keeping all that data current and accessible can be a major headache. Randolph Wang, a Princeton University computer scientist, hopes to relieve the pain with one mobile device. Designed to provide anytime, anywhere access to all your files, the device stores some data, but its main job is to wirelessly retrieve files from Internet-connected computers and deliver them to any computer you have access to. Wang's prototype is a PDA with both cellular and Wi-Fi connections, but the key is his software, which grabs and displays the most current data stored on multiple computers. Wang has tested his prototype with more than 40 university and home computers on and around the Princeton campus. He eventually wants to shrink the device down to the size of a wristwatch to make carrying it a snap.



Current lung scans often turn out fuzzy.



A new method yields clearer airway images.

LIGHTING UP LUNGS

MAGNETIC-RESONANCE IMAGING HAS DRAMATICALLY IMPROVED DOCTORS' views of the body. But obtaining clear pictures of the lungs has been a struggle. Now researchers at Harvard Medical School have found a way to make these MRIs crystal clear. In an experimental procedure for performing lung MRIs, a patient takes a breath of polarized helium, which naturally spreads through the lungs' branching airways to the oxygen-filtering sacs at their ends. The gas becomes magnetized and highlights the airways in the scan—but the sacs light up, too, which largely blocks the view. The Harvard researchers have improved upon this method: hyperpolarized helium is administered as the patient inhales for several seconds, while the MRI scanner records a series of images of the gas spreading through the airways. Radio-frequency pulses from the scanner also depolarize the helium that reaches the air sacs—producing clear images of just the airways. The technique could aid diagnoses of asthma and cystic fibrosis. Durham, NC-based startup Polarean is commercializing polarization systems that will enable these types of MRIs; the company plans to pursue FDA approval starting in 2005.

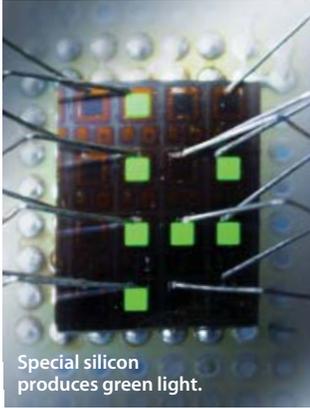
ACCENTUATE THE POSITIVE

THE AUTOMATED TELEPHONE CALL centers companies use to reduce costs can drive customers crazy. A way to spot impatience in callers' voices—and transfer them to human operators before they hang up—could ease the frustration. Shri Narayanan and Chul Min Lee at the University of Southern California have developed a system that distinguishes irritated from normal speech with up to 85 percent accuracy. Their program identifies specific acoustic features of speech that indicate stress, such as the pitch, energy, and duration of speech sounds, as well as word content and contextual information. The system "learned" what to look for through training on nearly 1,400 real phone calls. The team hopes to improve the software's accuracy but says it could already benefit companies.



Software can recognize callers' annoyance.

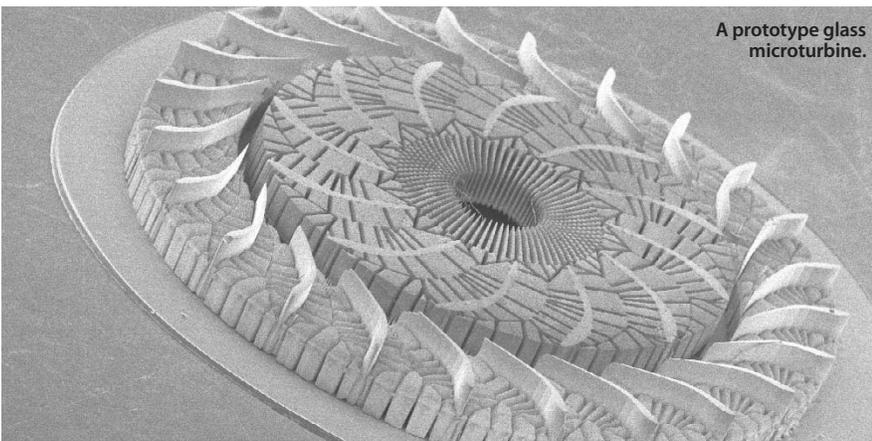
CORBIS (POSITIVE); COURTESY OF THE HYPERPOLARIZED NOBLE GAS MRI LABORATORY, BRIGHAM AND WOMEN'S HOSPITAL, HARVARD MEDICAL SCHOOL (LUNGS); COURTESY OF LUYI SEN, MD (GENES)



Special silicon produces green light.

GLOWING SILICON

OPTICAL CHIPS THAT TRANSMIT DATA ON BEAMS OF LIGHT PROMISE FASTER AND MORE reliable computing, but they have not caught on widely because they must use expensive, exotic semiconductor materials to emit light: plain silicon won't do the job. Now a research group led by physicist Salvatore Coffa at STMicroelectronics, headquartered in Geneva, Switzerland, has developed an all-silicon chip that combines both optics and electronics. Parts of the silicon are mixed with special rare-earth elements, which enables them to generate light about 100 times more efficiently than any previous silicon device, according to Coffa. The one-millimeter-square device uses light beams to talk to other chips. The STMicroelectronics chip's first applications will be in telecommunications and biomedical devices, but it could eventually enable new processors for high-end computers and cheaper lasers and plasma displays. Potential customers will test the chip by the middle of 2004, says Coffa, and it could be incorporated into "billions of devices" by 2007.



A prototype glass microturbine.

GLASS MICROMACHINES

FROM LABS-ON-A-CHIP THAT MIX TINY AMOUNTS OF FLUIDS IN BIOMEDICAL assays to the miniature radios envisioned for future cell phones, a growing number of devices require microscopic parts. More-complex parts are usually made, layer by layer, atop wafers of silicon. Now Invenios, a startup in Santa Barbara, CA, is experimenting with a faster, cheaper process that can create 3-D shapes as small as a cubic micrometer with a single pass of a laser. The technique, invented at Aerospace, an El Segundo, CA-based defense contractor, starts with a special kind of glass whose atoms are in a jumbled, unordered state. Guided by computer-aided-design files, a laser beam strikes certain areas inside the glass, displacing the atoms' electrons. Then, when heated, the treated parts of the glass form ordered, crystalline structures. The crystalline material is etched away by acid, leaving behind glass structures such as tiny turbines, microfluidic valves, or optical waveguides for fiber-optic systems. Thousands of millimeter-scale components could fit on a single wafer and could cost as little as 30 cents each in volume.

GOOD VIBRATIONS

TINY TREMORS IN YOUR OFFICE OR CAR COULD SOON POWER ALL sorts of small gadgets, thanks to MIT materials scientists Robert O'Handley and Jiankang Huang. The pair have developed devices less than five centimeters long that transform slight vibrations into usable electricity. Inside, a spring links a magnet and a coil of copper wire; minuscule movements of the magnet and coil produce an electric current. Attached to a rattling duct or water pump, the device generates a few milliwatts of power—enough to drive, say, a temperature sensor. The duo cofounded Ferro Solutions in Cambridge, MA, which is partnering with Cambridge, MA-based Millennial Net to build battery-free wireless sensors for factory and building management. Other anticipated applications include energy sources for automotive sensors, micromotors in printers, and even cell phones.



A new device uses vibrations to power a sensor.

TISSUE TESTER

Tissue engineers are working on ways to grow skin, cartilage, and bone in the lab so that injury victims don't have to rely on replacement tissues extracted from donors or from their own bodies. One obstacle researchers face is that while they can easily examine the health of cells on a tissue's surface, checking whether the cells deep inside are thriving or dying remains tricky. Chemical engineer Zhanfeng Cui of Oxford University has developed a small polymer probe that determines the cells' health instantaneously. A fraction of a millimeter in diameter, the needlelike probe can be inserted into growing tissue and measures the levels of certain key substances, such as nutrients or cellular waste products. The probe is made of a porous membrane that the target molecules can pass through; the number of molecules that enter correlates with their concentration in the tissue. Cui hopes to license the technology for commercial development or find investors for a startup to manufacture the probes. As commercial products, the probes could speed the development of tissue engineering—delivering new hope to desperate patients.

COURTESY OF FERRO SOLUTIONS (VIBRATIONS); COURTESY OF THE AEROSPACE CORPORATION (MICROMACHINES); COURTESY OF STMICROELECTRONICS (SILICON)