Tech Update

Is hydrogen the fuel of the future ?

Hydrogen is the new buzz word as oil companies and car makers back the view that it will be the successor to oil in the coming decades. Experimental fleets of hydrogen cars have been operating in California since last year. In hydrogen vehicles, an electric motor powers the wheels. A chemical reaction inside a unit called a fuel cell - usually between hydrogen and oxygen - creates electricity for the motor. The only emission is water vapour - although depending on how the hydrogen is generated, some air pollution may occur during the production process. It is expected that with the right commitment and investment, hydrogen cars could be ubiquitous within 10 years.

Scientists find new way to grow human embryonic stem cells

Scientists from the John Hopkins Institute have discovered that primitive human Embryonic Stem (ES) cells can be grown with the help of special cells from bone marrow, offering an easily obtained and well-studied source of human cells to nurture the human ES cells as they divide. First announced in 1998, human embryonic stem cells are usually grown in the laboratory on a "feeder layer" of mouse cells. Feeder cells send as yet unknown signals to the primitive human ES cells, preventing them from turning into more "grown-up" cell types, such as bone, fat, or brain cells. One concern with using mouse cells as the feeder layer for human ES cells is that an animal virus might be passed to people if the human ES cells someday are used to treat patients. Although such applications are in the fairly distant future, if human cells can act as feeders, new lines of human ES cells could be created without exposing them to mouse cells. Tests show that the human ES cells retain their primitive nature when grown on the stromal cells. After eight months of dividing under these conditions, the human embryonic stem cells still look and act just like the originals. Marrow stromal cells are also known as mesenchymal stem cells, which are capable naturally of becoming fat, cartilage and bone. Some animal experiments have suggested that mesenchymal stem cells can be manipulated to form other types of cells in laboratory dishes, but that is still being evaluated.

Waveguide to bypass diffraction limits for new optical devices

Four hundred years ago, a scientist could peer into one of the newfangled optical microscopes and see microorganisms, but nothing much smaller. Nowadays, a scientist can look in the latest generation of lens-based optical microscopes and also see, well, microorganisms, but nothing much smaller. The limiting factor has always been a fundamental property of the wave nature of light that fuzzes out images of objects much smaller than the wavelength of the light that illuminates these objects. This has hampered the ability to make and use optical devices smaller than the wavelength. But a new technological breakthrough in March 2003 at the California Institute of Technology could sidestep this long-standing barrier. Caltech applied physicists have announced their success in creating "the world's smallest waveguide called a plasmon waveguide, for the transport of energy in nanoscale systems." In essence, they have created a sort of "light pipe" constructed of a chain-array of several dozen microscopic metal silvers that allows light to hop along the chain and circumvent the diffraction limit. With such technology, there is the clear possibility that optical components can be constructed for a huge number of technological applications in which the diffraction limit is troublesome. Since the era of

nanoscale devices is rapidly approaching, in future extremely tiny optical devices would be connected to molecules and someday even to individual atoms. At present, the plasmon waveguide looks something like a standard glass microscope slide. Fabricated on the glass plate by means of electron beam lithography is a series of nanoparticles, each about 30 nanometers in width, about 30 nanometers in height, and about 90 nanometers in length. These etched "rods" are arranged in a parallel series like railroad ties, with such a tiny space between them that light energy can move along with very little radiated loss. In addition to their functionality as miniature optical waveguides, these structures are also sensitive to the presence of biomolecules. Thus a virus or even single molecule of a gas could conceivably be detected. The ultrasmall waveguide could also be used to optically interconnect to electronic devices, because individual transistors on a microchip are already too small to be seen in a conventional optical microscope.

New high resolution metamaterial lens

By constructing artificial materials that break long standing rules of nature, the researchers of the University of Toronto have developed a flat lens that could significantly enhance the resolution of imaged objects. This, in turn, could lead to smaller and more effective antennas and devices for cell phones, increased space for data storage on CD-ROMs and more complex electronic circuits. This will provide an opportunity to resolve details in an object smaller than a wavelength. The team works in the rapidly emerging field of metamaterials, artificially created substances with properties not found in nature. Under normal electromagnetic conditions, light passing through a flat lens will diverge; light passing through a lens made of metamaterials, however, will bend the "wrong" way and become focused. Their study reveals that when evanescent waves - weak but important waves that lose strength quickly after leaving their source - are directed through the flat metamaterial lens, these waves are amplified. At the same time, the lens corrects the phase of the waves by focusing the diverging waves into a beam. Metamaterial lenses, when constructed at optical frequencies, could be used to engineer the next generation of electronic devices at the nanometer scale.

Miniature spectrometer can detect biological hazards

Researchers at the U.S.Department of Energy's Oak Ridge National Laboratory have developed a miniature devices that can identify as little as a fraction of a spore of anthrax and other biological hazards within 30 milliseconds. The Calorimetric Spectrometer (CalSpec TM) device technology can accurately identify biological hazards such as anthrax almost instantly. The device can operate with only a fraction of a spore while isolating the DNA/RNA photothermal signature that allows for detection, identification and measurement of a substance. Such prompt detection and identification of hazardous materials could greatly enhance the protection of first-responder emergency personnel and the capabilities of early warning systems. Current technologies do not provide the level of sensitivity offered by the CalSpec TM chemical, biological and DNA/RNA detection system. The CalSpec TM can detect hazards by identifying their molecules. The molecular absorption can induce stress changes that allow for an initial detection that can be used for measurement. The identification of chemical and/or biological molecules, along with DNA/RNA, creates a photothermal signature. The spectrometer could have a wide variety of applications in commercial industry and in homeland defense, including mass transit and airport security; in the postal industry, to protect workers and the public; and in monitoring air quality systems. The device will be offered as both a laboratory and field-test device for chemical, biological and DNA/RNA detection. It is expected to be on the market by 2004.

FAST protocol to speed up internet

Caltech computer scientists have developed a new data transfer protocol for the internet fast enough

to download a full-length DVD movie in less than five seconds. The protocol is called FAST, standing for Fast Active queue management Scalable Transmission Control Protocol (TCP). The researchers have achieved a speed of 8,609 Mbps by using 10 simultaneous flows of data over routed paths, the largest aggregate throughput ever accomplished in such a configuration. More importantly, the FAST protocol sustained this speed using standard packet size, stably, over an extended period on shared networks in the presence of background traffic, making it adaptable for deployment on the world's high-speed production networks. Using standard packet size that is supported throughout today's networks, the current TCP typically achieves an average throughput of 266 Mbps. The FAST TCP sustained an average throughput of 925 Mbps and an efficiency of 95 percent, a 3.5-times improvement under the same experimental condition. With 10 concurent TCP/IP flows, the unprecedented speed of FAST of 8,609 Mbps, at 88 percent efficiency is 153,000 times that of today's modern and close to 6,000 times that of the common standard for ADSL (Asymmetric Digital Subscriber Line) connections. Rapid and reliable data transport, at speeds of 1 to 10 Gbps and 100 Gbps in the future, is a key enabler of the global collaborations in physics and other fields. The ability to analyze and share many terabyte-scale data collections, accessed and transported in minutes, rather than over hours or days as is the current practice, is at the heart of the process of search and discovery for new scientific knowldge.

Contact lenses that dispense prescription drugs

Eye diseases like glaucoma could one day be treated by pharmaceuticals delivered through contact lenses. Chemical engineers from the University of Florida, U.S.A. say they have been able to make soft contact lenses containing tiny embedded particles that slowly release drugs directly where they're needed. In theory, the disposable, drug-laden contact lenses could be worn for up to two weeks, steadily delivering a supply of the drug directly to the eye where it's needed, rather than being exposed to a sudden high dose of medication - from an eye drop. The patient, as a result, gets the right amount of medicine all the time. The same lenses could be used to correct vision while delivering medication. The lenses are in the very early engineering design stages and have not been tested clinically.

Roman nose detects cancer

University of Rome scientists have pioneered an electronic nose that, they say, may one day give an early warning to people with lung cancer. The experimental device works in the same way as hi-tech hygiene 'sniffers' that are already in use in the food industry, which analyse air on the production line for the tell-tale chemicals released by rotting ingredients.

In lung cancer, the e-nose responds to alkanes and derivatives of benzene exhaled by someone with the disease. The nose proved to be 100% accurate in a test at a hospital in which it analysed a breath sample from 35 people with a large lung tumour and 25 others who are healthy.

The next step is to boost its sensitivity so that it can detect tumours at much earlier stage. It could be used in routine checkups to screen smokers and other high risk groups. The present technique for diagnosing someone with a lung cancer is invasive, for it requires a doctor to use a bronchoscope to peer inside the patient's lungs and remove a sample for examination under a microscope.