Innovations Report

Jun 2006 Part II

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ICT

WiMAX Cell Phones Edge Closer to Reality

Power-saving chips are paving the way for super-broadband handheld devices

WiMAX, the souped-up successor to the WiFi wireless standard, could greatly increase the amount of information that cell phones and other mobile devices can pull from the air. Until recently, however, the elaborate antenna technology needed for sending and receiving WiMAX signals has been a big drain on a mobile device's batteries. Now that the telecommunications industry has settled on final specifications for WiMAX, though, including provisions for power efficiency, manufacturers are exploring ways to build the energy-efficient chips needed to make consumer WiMAX devices viable.

WiMAX-enabled handhelds would be able to access greater bandwidth than traditional cellular networks, allowing faster streaming media and Internet downloads. Moreover, WiMAX phones using Voice over Internet Protocol (VoIP) might drop fewer calls and keep working up to 50 kilometers away from base stations, compared with 16 kilometers for cellular networks and WiFi's mere 100 meters. Some phones already come equipped with a WiFi chip and can access local WiFi hotspots in addition to cellular networks. But WiFi coverage is spotty -- while WiMAX signals beamed from central towers could blanket entire metropolitan areas. In addition, WiMAX signals can carry 70 megabits of data per second -- more than three times the roughly 20 megabits from WiFi, and far outperforming the 300 kilobits on cellular networks.

So far, only a handful of businesses in large U.S. cities are taking advantage of WiMAX technology, using equipment installed before the recent standards were finalized. In December 2005, the Institute of Electronics and Electrical Engineers (which created the WiFi (802.11) standard) agreed on technical specifications for mobile WiMAX. Now large companies, including Intel, Alcatel, and Qualcomm, are pushing to develop WiMAX-compliant base station and chipset technologies. Also, in the next few months, the WiMAX Forum, a consortium of companies making and deploying WiMAX equipment, will begin testing and approving mobile products.

Unlike cellular chipsets, which can access only a narrow band of the radio spectrum, often making downloads slower, WiMAX chipsets are designed to tune into and process broader swaths of the radio spectrum. Collecting and processing more of the radio spectrum requires more power, though, because more frequencies must be sorted through. In addition, most WiMAX equipment uses antenna technology called MIMO (Multiple Input, Multiple Output), which uses more than one antenna to simultaneously collect and send more information greater distances, and power-hungry signal processing algorithms are needed to sort through the information collected via MIMO connections.

The power problem is even more formidable for manufacturers who want to build chips for multi-band WiMAX phone for use in different parts of the world. Each region, such as the United States and Asia, is setting aside a different portion of the spectrum for WiMAX, and accessing multiple bands usually requires a separate chip for each band.
"WiMAX is a very powerful and elaborate standard where the bandwidth can be selected for in different parts of the world. We've had to craft an RF integrated circuit that's capable of performing anywhere." If two separate single-band chips were used to solve the multiband problem, each radio would require separate sets of circuitry, which would operate redundantly, wasting power and draining the device's battery. A new combined circuit by Sierra Monolithics saves space and uses less than 300 milliwatts of power to access two WiMAX bands, while two single-band chipsets would each consume about 220 milliwatts of power.

Breakthrough In Silicon Photonics Devices

Building on a series of recent breakthroughs in silicon photonics, researchers at the UCLA Henry Samueli School of Engineering and Applied Science have developed a novel approach to silicon devices that combines light amplification with a photovoltaic – or solar panel – effect.
The researchers report that not only can optical amplification in silicon be achieved with zero power consumption, but power can now be generated in the process.

"After dominating the electronics industry for decades, silicon is now on the verge of becoming the material of choice for the photonics industry, the traditional stronghold of today's semiconductors," said Bahram Jalali, the UCLA leading author of the work.

The amount of information that can be sent through an optical wire is directly related to the intensity of the light. In order to perform some of the key functions in optical networking – such as amplification, wavelength conversion, and optical switching – silicon must be illuminated with high intensity light to take advantage of its nonlinear properties. One example is the Raman effect, a phenomenon that occurs at high optical intensities and is behind many recent breakthroughs in silicon photonics, including the first optical amplifiers and lasers made in silicon.
The fundamental challenge in silicon photonics is the material stops being transparent at high optical intensities, making light unable to pass through.

"As light intensifies in silicon, it generates electrons through a process called two-photon-absorption. Excess electrons absorb the light and turn it into heat. Not only is the light and the data-carrying capacity lost, the phenomenon exacerbates one of the main obstacles in the semiconductor industry, which is excessive heating of chips. The optical loss also makes it all but impossible to create optical amplifiers and lasers that operate continuously," Jalali explained.
"In the past, two-photon absorption in silicon has resulted in significant loss for high power Raman amplifiers and lasers, reducing efficiency and necessitating complex mitigation schemes. UCLA Engineering's new development will enable recycling power that would otherwise be lost."

"This discovery is a step forward and makes it much more likely that the photonics and electronics will converge. If they do, many applications that silicon photonics has promised will come to fruition," Jalali said.Silicon photonics technology has the potential to use the power of optical networking inside computers and to create new generation of miniaturized and low-cost photonic components, among other applications.

Microelectronics & Nanotech

Nanowire Transistors Faster than Silicon

Advances in nanowires show they can be fast enough to use as ultrasmall transistors in cheap, high-performance electronics.

Researchers at Harvard University have shown that nanowire transistors can be at least four times speedier than conventional silicon devices. The principal researcher, Charles Lieber, says this could lead to inexpensive, high-performance, flexible electronic circuitry for cell phones and displays. It could also save space and further increase speed by allowing memory, logic, and sensing layers to be assembled on the same chip.

Nanowires have been considered a promising contender for use on future logic chips because of their very small size (about 10 nanometers wide) and because they can be made without complicated lithography. Until now, though, the performance of nanowire-based transistors has lagged far behind that of other potential nano devices, such as carbon nanotubes, and even conventional devices. But the new Harvard research suggests that nanowires have surpassed conventional transistors and nearly caught up with nanotubes. This may give nanowires an edge over carbon nanotubes. Nanowires are made with regular crystal structures and uniform electronic properties -- a level of predictability essential for manufacturing high-performance electronics. Nanotubes, however, come in batches of different sizes and structures, each of which can perform very differently -- so until a good sorting method can be found, it will be difficult to use nanotubes in high-end processors.

The first applications for nanowires will likely be ultra-sensitive sensors for single molecule detection (when molecules bind to the nanowires they create a detectable change in the current flowing through the wires). Such applications could be ready in two to three years, Lieber says.

Nanowire transistors may never replace more conventional devices in computer chips used in laptops and personal computers -- the cost of developing large-scale manufacturing would probably not be justified by a 4 to 5 times improvement in performance, but the new performance figures suggest it will be well worth scaling up the technology to manufacture them for applications where the ability to assemble nanowire transistors at room temperature on various surfaces, including plastic, will bring an added advantage. For instance, in flexible displays nanowire transistors could be used to embed information-processing in the screen itself.

The technology might also be useful for extremely compact devices, since it would be possible to layer memory, logic, and even sensing circuitry on top of each other, rather than side by side or on separate chips. The nanowires are applied to chips and connected to the source, drain, and gate using room-temperature processes, allowing consecutive layers to be applied without damaging previous layers. "If you can put ultra-high-performance materials into 3-D structures, through layer by layer assembly, it allows you to put a lot more stuff into an area," says Lieber. The proximity of the layers, a mere 100 nanometers apart, could also speed performance.

One of the qualities that distinguishes this current is that the measurements used are industry standards, which makes it possible to compare how nanowires would perform in real devices.The key to the improved performance is a "core-shell" structure of the nanowires, which confines electrons, or their counterparts, electron holes, in a small space. That allows electrons to zip through the wires quickly, which is key to the speed improvements. In a recent paper in the journal Nature, Lieber made nanowires with a germanium center surrounded by a thin coating of crystalline silicon. And in work described in Nano Letters, the researchers showed the versatility of nanowires by using gallium nitride, which could be useful for high-power, high-temperature applications.

Abalone-inspired material may one day transform chip making

Belcher, of the Massachusetts Institute of Technology, has been studying how abalones used proteins to create thin layers of films to make exquisitely hard shells. By mimicking this process, she came up with the idea for a new company. It turns out that the abalone-like process mirrored similar methods for manufacturing semiconductor chips and flat-panel displays.

That was how Cambrios, a Calif. start-up, was born. Now the company is preparing to launch new materials that can be grown using the tools that came from Belcher's research on the abalone shell. And some people think the new materials could pave the way for making semiconductor chips that are faster and use less power.

Belcher's discovery was compelling enough to attract a solid team and $1.8 million in venture funding in 2003. The company started work on the technologies and expects its first product, a transparent material that conducts electricity and can make TV screens clearer, to debut in 2007.

Knapp estimates that the market for indium tin oxide, the material that Cambrios could replace, is about $1 billion a year. If the company keeps coming up with new materials, it could help the chip industry deal with looming barriers for further progress in chip making, such as reducing heat emissions from chips.

In manufacturing, Cambrios essentially finds proteins that will self-assemble, or stick to the surface of a material on a silicon wafer. The electronics designers will create a pattern for electrical circuits on the wafer using that material. The proteins stick to part of the wafer with the material, but not the parts without it. Hence, they are used as a kind of template to create patterns on the wafer.

Belcher says the company is examining also a few dozen different applications for the technology in optical, solar, magnetic and semiconductor fields. On a solar cell, for instance, Cambrios could make a better electrode on a solar cell.

'Silicon Velcro' could make sticky chips

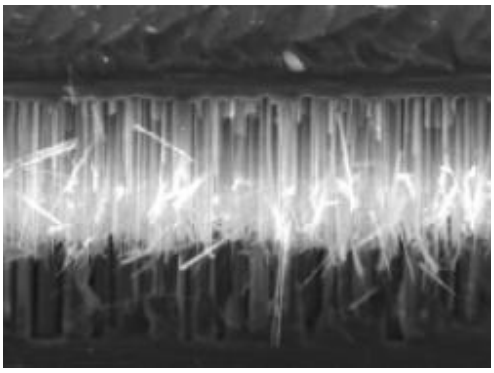
An exotic form of silicon that can be stuck together and then peeled apart has been developed by German researchers. The material, dubbed "silicon Velcro", could be used to manufacture microprocessors and devices that manipulate fluids on microscopic scales.

Researchers at the Technical University of Ilmenau in Germany created the material from "black silicon". This is generated when normal silicon is hit with a powerful laser beam or bombarded with high-energy ions, producing a dense, microscopic array of needle-like structures on its surface. Light bounces around between the needles without escaping to give the material its black appearance. The German team used high-energy ions to generate black silicon bristling with around 1 million needles per square millimetre. Each needle is about 15 to 25 micrometres in length. They found that two surfaces covered with the material adhere when pressed together. Microscope analysis shows this is because the needles on each surface jam in between one another under pressure.

Members of the research team say silicon Velcro could prove useful for microchip manufacturers. It could help engineers manipulate very thin layers of silicon without using heat or adhesives, which can damage components. "The Velcro could be used as a carrier system, to pick up the thin wafer and hold it for processing."

The material can also be used to create devices that control the flow of fluids on microscopic scales, for chemical sensing and analysis. These devices are made by sticking together a layer covered with tiny grooves and another, smooth layer. The layers of silicon Velcro can be unstuck afterwards to retrieve a valuable substance or examine what has happened inside.

Silicon Velcro can be used more than once, but not indefinitely since some of the needles break with use.



‘Silicon Velcro' (Image: IOP Publishing/Journal of Micromechanics and Microengineering)

Journal of Micromechanics and Microengineering (vol 16, p S82)

Dry ice creates toughened glass

A form of solid carbon dioxide that could be used to make ultra-hard glass or coatings for microelectronic devices has been discovered.
The material, named amorphous carbonia, was created by scientists from the University of Florence in Italy. Writing in the journal Nature, the team says the material was theoretically possible but had never been created. Scientists are interested in the new material because of the potential applications..

Recently, scientists in California coaxed carbon dioxide molecules to form a solid network by applying extreme pressure at high temperatures. Their discovery could lead to a way of storing or disposing of carbon dioxide gas, a major contributor to global warming, deep in the Earth's interior.

To create the glassy amorphous carbonia, the team led by Professors Mario Santoro and Federico Gorelli heated solid carbon dioxide between diamond teeth at pressures over 400,000 times greater than atmospheric pressure. The material was then cooled to room temperature to form the glass. Atomic analysis of the material confirmed the glass had a similar structure to silica, but is thought to be much harder and stiffer, like diamond. When the material is depressurised, it returns to a solid formed of discrete molecules. The next stage of the research is to work out how to make the glass stable at room temperature and pressure.

Applications could include ultra-tough glass or protective coatings for micro electronics. However, in the first instance, it will give planetary scientists insights into what happens in the interior of huge planets known as gas giants such as Jupiter. These findings will also help set the rules for understanding structure, bonding and thermodynamic properties as we move our experiments into the high pressure, high temperature conditions mimicking those deep inside planetary interiors,"

Energy

Quantum-Dot Solar Cells

Tapping tiny crystals' inexplicable light-harvesting talent

One frustration of solar energy is that although it's free, clean, and inexhaustible, it's a major challenge to harvest efficiently. Consider what happens when photons of sunlight hit a solar cell: They strike electrons in semiconductor material and send them on their way as an electric current. Although many solar photons carry enough energy to theoretically unleash several electrons, they almost never free more than one.

Turning from conventional power sources to solar power, scientists are using tiny semiconductor crystals, or quantum dots, to take advantage of energy wasted by today's photovoltaic cells. As researchers strive to exploit this newfound economy, they're quarreling about how quantum physics might explain it.

The complex physics behind that limitation boils down to this: An electron loosed by absorbing a photon often collides with a nearby atom. But when it does, it's less likely to set another electron free than it is to create atomic vibrations that squander the electron's excess energy on heat. For the past half century, the limit of one electron per solar photon seemed a regrettable fact of semiconductor physics. However, in recent tests of semiconductor bits only a few nanometers in diameter -entities known as nanocrystals or quantum dots- researchers have been surprised to find that photons at solar energies commonly unleash multiple electrons. The number set loose depends on the dot's composition and—as a quirk of quantum mechanics—its size. Recent experiments on 8-nanometer-diameter lead selenide quantum dots have given the best results so far: Ultraviolet-light photons—albeit at a wavelength found sparingly in sunlight—released seven electrons apiece.

That leap in producing electrons could lead to major improvements in solar cell efficiencies, the researchers say, that is, if those electrons can be harvested from the cells. So far, evidence from prototype solar cells and photodetectors suggests that the newfound effect can indeed improve cells' power outputs. "It's not just a pipedream to think about this [multiplication effect] giving you a real benefit in a solar cell device," says Richard. Schaller of Los Alamos National Laboratory. Other technologies that might benefit include lasers that operate at useful wavelengths not attainable with other materials and solar water splitters that produce hydrogen for fuel cells

Whereas the new effect's practical potential is apparent, the means by which solar photons yield so many electrons is not. In a heated debate, some scientists argue that a previously unseen type of quantum mechanical entity must briefly form in each quantum dot. Others contend that an already well-understood process can account for the multiple-electron output. In the electrical realm, semiconductors occupy a middle ground between insulators and conductors. Whereas atoms of insulators bind their electrons tightly, conductor atoms let those negatively charged particles roam free. In contrast, semiconductor atoms hold their electrons until given small energy boosts. Then, the electrons are available to flow as current. If a photon strikes an electron in a semiconductor with more than the threshold amount of oomph, called the material's band-gap energy, the electron breaks loose. It leaves behind a vacancy, known as a hole, in the atom's electronic structure. Each free electron–hole pair created by a photon is called an exciton.

Despite the one-photon-one-exciton rule that solar-energy specialists had observed when photons hit the semiconductors in their power cells, physicists had known since the 1950s that photons at much higher energies could give rise to multiple excitons. Scientists also determined that such multiple-exciton production takes place by means of a process called impact ionization. Roughly speaking, an electron from an exciton strikes an electron bound to an atom, creating another exciton. If enough excess energy remains in the newly formed exciton, its electron can create yet another exciton, and so on. However, at the relatively low energies of solar photons, subtleties related to electron motion largely prevent the exciton-to-electron energy transfers, so only negligible impact ionization occurs.

Quantum dots introduce another factor: size. The wavelike nature of electrons, as dictated by quantum mechanics, makes itself felt at the dot's minuscule dimensions. For instance, a dot has a larger band-gap energy than does the same semiconductor material in bulk, so the dot absorbs higher-energy, bluer light. Also, because a dot is often as small in diameter as the wavelength of an electron inside it, the dot immobilizes the electron. About a decade ago, it was began to suspect that the smallness of quantum dots might make impact ionization a fruitful process at solar-radiation energies.

At Los Alamos Schaller and Victor I. Klimov began studying lead selenide nanocrystals and they saw the first evidence of solar-energy photons creating more than one exciton apiece. In a 2004 report, the Los Alamos physicists reported that photons could generate as many as three excitons apiece in lead selenide quantum dots. A year later they also unveiled the first evidence for multiple excitons from another type of quantum dot, made of lead sulfide and then also in cadmium selenide quantum dots. At the beginning of this year the group reported that, using lead selenide quantum dots and some ultraviolet-light photons, they could trigger seven excitons apiece. Currently, the researchers are examining cadmium telluride nanocrystals.

Another group of researchers from NREL reported this year that lead telluride dots produce up to three excitons from single solar-energy photons.

Regardless of exactly how much photon energy is needed, even the most modest boost in solar cells—say, to two excitons per photon—would be a major, major achievement.

Other more complex multiple-exciton effects are also under research and if they pan out in practical devices, solar cell efficiencies could soar. Both the Los Alamos and NREL teams calculate a maximum of 42 percent conversion of solar power to usable electricity. Conventional cells, by contrast, operate at 15 to 20 percent efficiency.

For instance, a university of Texas at Dallas team working with Klimov and Schaller made experimental solar cells by blending 8-nm-diameter lead selenide quantum dots with another conductive polymer called polythiophene. Again multiple excitons per photon were observed.

Generating extra excitons might also have a major impact on equipment that uses solar energy to split water to extract its hydrogen for various uses—for instance, to energize fuel cells—Klimov says. Each water-splitting reaction requires four electrons, he notes, so the more electrons per solar photon the better.

Scientists have used quantum dots to make laser beams of wavelengths not available with natural dyes or crystals. The boost in exciton productivity could also make such lasers more efficient.

Nanoparticle ink and roll-to-roll printing for solar cells

Nanosolar Inc., a Palo Alto, Calif., company developing photovoltaic technology using nanoparticle ink and roll-to-roll printing technology, announced it has raised a Series C funding round of more than $75 million. The company said it will use the financing, as well as $25 million in previously-raised funds, to move into volume production.
The company announced that it has started executing on its plan to build a volume cell production factory with a total annual cell output of 430MW once fully built out, or approximately 200 million cells per year, and an advanced panel assembly factory designed to produce more than one million solar panels per year.

Presently in pilot production in its Palo Alto facility, Nanosolar said it has started ordering volume production equipment for what it said is going to be the world's largest solar cell manufacturing factory. Solar cells are ordinarily built using wafer production technology. As a result, volume production facilities usually cost significantly more to build.

"Thin-film printing overcomes the complexity, high cost, and yield and scalability limitations associated with vacuum-based processes. Nanosolar’s technology enables low-cost, high-yield production previously attainable," said Chris Eberspacher, Nanosolar's head of technology, in a prepared statement. "This allows us to produce cells very inexpensively and assemble them into panels that are comparable in efficiency to that of high-volume silicon based PV panels."

"Given the square meter economics of solar, high-throughput high-yield processes have to be used to succeed in this industry. With Nanosolar's printing process, the fully-loaded cell cost -- including materials, consumables, energy, labor, facility, and capital -- is less than the depreciation expense alone that vacuum thin-film companies have to pay for the equipment that produces their cells," said Werner Dumanski, Nanosolar's head of manufacturing, in a prepared statement.

Finding A Better Way To Make Biodiesel

Victor Lin and a team of Iowa State researchers have found a better way to make biodiesel. The researchers are after a new, high-tech catalyst that takes some of the energy, labor and toxic chemicals out of biodiesel production. They've come up with a technology that works in the laboratory and now they're working to test their discoveries on a larger scale. They're also working to establish a company that would move the new technology into biorefineries.

Current biodiesel production technology reacts soy oil with methanol using toxic, corrosive and flammable sodium methoxide as a catalyst. Getting biodiesel out of the chemical mixture requires acid neutralization, water washes and separation steps. It's a tedious process that dissolves the catalysts so they can't be used again. So Lin and his research team started looking for technologies that would create an easier, more efficient and more economical process. They were also hoping to find technologies that would effectively make biodiesel out of raw materials such as used restaurant oils and animal fats -- materials that are much cheaper than soy oil, but also contain free fatty acids that can't be converted to biodiesel by current production methods.

Lin has developed a nanotechnology that accurately controls the production of tiny, uniformly shaped silica particles. Running all the way through the particles are honeycombs of relatively large channels that can be filled with a catalyst that reacts with soybean oil to create biodiesel. The particles can also be loaded with chemical gatekeepers that encourage the soybean oil to enter the channels where chemical reactions take place. The results include faster conversion to biodiesel, a catalyst that can be recycled and elimination of the wash step in the production process.

Lin's particles can also be used as a catalyst to efficiently convert animal fats into biodiesel by creating a mixed oxide catalyst that has both acidic and basic catalytic sites. Acidic catalysts on the particle can convert the free fatty acids to biodiesel while basic catalysts can convert the oils into fuel. And the particles themselves are environmentally safe because they are made of calcium and sand.

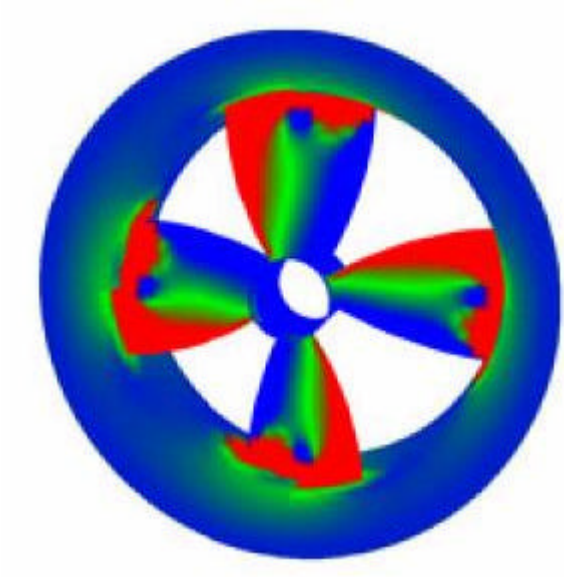
Compact Tidal Generator Could Reduce The Cost Of Producing Electricity From Flowing Water

Dr Steve Turnock and Dr Suleiman Abu-Sharkh from the University of Southampton had successfully built a very efficient generator for producing electricity from water flow. What's new about the Southampton design is its simplicity. "This is a compact design that does away with many of the moving parts found in current marine turbines. It's a new take on tidal energy generation," Most current tidal stream generators are essentially wind turbines turned upside down and made to work underwater. They often include complex gearboxes and move the entire assembly to face the flow of the water. Gears and moving parts require expensive maintenance, especially when they are used underwater. This pushes up the cost of running the turbines, a cost that is passed on to the consumers of the generated electricity.

The Southampton design does not need to turn around because the design of its turbine blades means that they turn equally well, regardless of which way the water flows past them. The blades are also placed in a specially shaped housing that helps channel the water smoothly through the turbine.

Another beauty of the Southampton design is that everything is wrapped in a single package that can be prefabricated so there will be few on-site construction costs. "Just drop it into flowing water and it will start generating electricity. It will work best in fast flowing, shallow water,"

The present prototype is just twenty-five centimetres across and the research team now plan to design a larger model with improved propeller blades that will further increase the efficiency of generating electricity. All being well, the team envisage the generator becoming commercially available in 5 years



Life Sciences

Speeding Discovery Of The 'Human Cancer Genome'

Two gene discoveries announced in separate reports in the June 30, 2006 issue of Cell highlight one way to speed through the human genome in search of those genes most important for spawning cancer. Both groups say that a critical element in the enterprise to efficiently characterize the "human cancer genome" --a comprehensive collection of the genetic alterations responsible for major cancers--is the strategic comparison of human tumors with those of mice.

As a demonstration of the value of such strategic comparisons between species, the researchers report promising finds: one of the research teams identified two genes that can conspire to produce liver cancer, while the second uncovered a gene important to the spread of melanoma, the most serious form of skin cancer. Such functionally important genes, and the larger genetic pathways of which they are a part, are also those with the most promise as potential targets for cancer drugs, according to the researchers.

"With improvements in genome technology, we've found that human cancer is noisy," said Scott Lowe of Howard Hughes Medical Institute . "There are lots of alterations, only some of which causally contribute to the disease. Genetically engineered mice, by definition, develop more defined cancers than humans," he said. "Mice can therefore be used as a filter to help reduce that noise, and as a tool to determine, in areas of chromosomal alteration, what changes are functionally relevant." The difficulty stems from the fact that studies that scan the genomes of human tumors for differences typically find hundreds to thousands of genes that distinguish cancer and noncancer. Some of those differences are at the root of the cancer, while others are what Lowe refers to as "evolutionary byproducts." Simply sorting through those differences one by one takes time and money, said Lynda Chin of the Dana-Farber Cancer Institute and Harvard Medical School. Therefore Chin's and Lowe's groups relied on large-scale structural changes to chromosomes as a way of identifying areas of the genome with potential importance for cancer. Such chromosomal rearrangements often lead to the amplification of cancer-causing genes or the loss of genes that normally suppress tumor formation. But as genome technology continues to improve, providing ever-increasing resolution, researchers have found more than they had expected.

In human melanoma, for example, more than 100 genomic regions exhibit recurring structural changes, not all of which appear to be important. One way to narrow down the number of regions is to look for chromosomal alterations found in both humans and in the complementary, or syntenic, regions of the mouse genome. Chin’s team succeeded in identifying one and only one common factor: a consistently elevated level of the protein called Nedd9. To find out whether Nedd9 could play a role in skin cancer's spread, the researchers blocked the protein in both mouse and human metastatic melanoma cells. Cancer cells without active Nedd9 lost their ability to invade. Drugs aimed at Nedd9 might therefore prevent the skin cancer's spread.
Taking a similar approach, Lowe's team identified two genes that can work together to encourage one form of liver cancer, called hepatocellular carcinoma. Hepatocellular carcinoma is the 5th most frequent form of cancer worldwide but, owing to the lack of effective treatment options, represents the 3rd leading cause of death. Lowe's team relied on mice with specific pathological changes known to play a role in some liver cancers. They then searched for other spontaneous mutations in the animals' tumors and compared them to recurrent alterations observed in the human disease. That comparison narrowed the field to two genes that appear to "drive" liver tumors in both species: a gene called cIAP1, known to inhibit cell death, and a transcription factor called Yap. Both are required to sustain rapid growth of the tumors, they showed. As the chromosomal region under study is found in 5-10% of human tumor types, including lung, ovarian, esophageal, and liver carcinomas, the findings suggest the overall contribution of cIAP1 and Yap to human cancer may be substantial, the researchers said.

GM tomatoes attack human diseases HIV and Hepatitis B

GENETICALLY modified tomatoes containing edible vaccine are to be used to challenge two of the world's most lethal viruses.The aim is to create affordable vaccines for HIV and the hepatitis B virus (HBV) that could be easily grown and processed in the countries where they are most needed. So far, none of the 90 or so potential vaccines against HIV have proved successful and, though a vaccine already exists for HBV, it is too expensive to be used by poorer countries.

Rurik Salyaev at the Siberian Institute of Plant Physiology and Biochemistry in Irkutsk, Russia, and his colleagues used a bacterium to shuttle a synthetic combination of HIV and HBV DNA fragments into tomato plants. These include fragments of genes for various HIV proteins and the gene for an HBV protein called HBV surface antigen. The tomato plants then manufacture the proteins and, like the oral polio vaccine, when the tomatoes are eaten, these proteins prompt the body to create antibodies against the viruses.

Mice fed a solution containing the tomatoes in powdered form developed high levels of antibodies in their blood to both viruses. Equally important, the researchers found antibodies on mucosal surfaces, where the viruses can gain entry to the body through sexual contact. "That's where you want it to be protective," says Rose Hammond of the US Department of Agriculture which is collaborating with the Russian researchers.

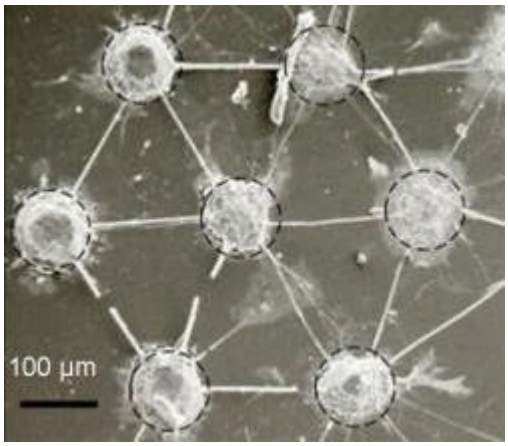
If the tomato-based vaccines work in humans they could be given in tablet form, since giving people the tomatoes directly would make it difficult to control how much protein they received. "You wouldn't have to refrigerate the vaccine, and you wouldn't need to inject it with needles, which pose an infection risk," says Hammond. These would be big advantages in poorer countries.

Tomatoes are not the first vegetables people have used to make vaccines. Charles Arntzen of Arizona State University in Tempe has produced potatoes that stimulate protective antibodies against HBV when eaten raw, although the recipients had previously been vaccinated against the virus, potentially masking the effects. Arntzen is awaiting permission to continue his research.

Neurons self-organise to make brain chips

A team led by Yael Hanein of Tel Aviv University in Israel used 100-micrometre-wide bundles of nanotubes to coax rat neurons into forming regular patterns on a sheet of quartz.
The neurons cannot stick to the quartz surface but do bind to the nanotube dots, in clusters of about between 20 and 100. Once attached, these neuron bundles are just the right distance from one another to stretch out projections called axons and dendrites to make links with other clusters nearby. Axons and dendrites carry electrical signals between neurons.

Existing methods for growing networks of neurons cannot produce such neat patterns and clean links between cells. This is because neurons are normally deposited on surfaces that do not prevent them from growing out of ordered clusters onto projections, which makes for a messier network. This is not a problem for Hanein's group. The process makes it possible to create more uniform neural networks, Hanein says. In experiments they last longer than other artificial networks, surviving for up to 11 weeks. This could be crucial for building biosensors using the cells, she claims.



Journal reference: Journal of Neural Engineering (vol3, p95)

Encyclopedia of all human gene mutations planned

A plan for a global database of all human gene mutations has been announced in Australia. The Human Variome Project could allow doctors to rapidly diagnose patients with rare genetic conditions and could ultimately lead to new treatments for diseases.

About 100,000 human gene mutations have been discovered, but this total represents only about 5% of the predicted total number of mutations.Some of the known genetic mutations are in existing databases, but there is no systematic global method for collecting and sharing complete information with researchers and clinicians around the world, says Richard Cotton, director of the Genomics Disorders Research Centre in Melbourne.

Cotton and colleagues announced the plan at a World Health Organization-sponsored conference in Melbourne on Friday. Initially the HVP will include information on single-gene disorders. Between 5000 and 6000 such disorders have already been identified, but this figure is predicted to reach about 23,000 ultimately.

The HVP also needs an estimated US$60 million over five years - and it is not yet clear where that money will come from, though web giant Google has said it is interested in providing some funds, Cotton says.

Parkinson's Disease Mechanism Discovered

Howard Hughes Medical Institute researchers have pinpointed defects in a critical cellular pathway that can lead to the death of dopamine-producing nerve cells and ultimately symptoms of Parkinson's disease. They have also used several animal models of the disease to identify a new way to rescue dying neurons. According to the researchers, the findings offer a promising opportunity for developing new drugs to treat the underlying causes of Parkinson's disease and related neurodegenerative disorders.
The research team, Susan L. Lindquist and Nancy M. Bonini, published their findings on June 22, 2006, in Science Express.

The researchers' began their experiments seeking to clarify the role of the protein alpha-synuclein in Parkinson's disease. It had long been known that abnormalities in alpha-synuclein could cause a lethal buildup of the protein in neurons. Researchers also knew that accumulation of alpha-synuclein caused neurodegeneration in animal models of Parkinson's disease, but little was known about alpha-synuclein's normal cellular function or how it contributed to disease aside from the fact that an important early defect affected the machinery that transports proteins between two major cellular organelles — the endoplasmic reticulum (ER) and the Golgi apparatus. The endoplasmic reticulum is the site of protein production, and the Golgi apparatus is the cell's "post office," which modifies, sorts and adds the molecular addresses that designate the specific destinations in the cell where proteins are needed.
Lindquist and her colleagues had conducted a genetic screen in yeast to discover genes whose activity affected the toxicity of alpha-synuclein. That study showed that genes enhancing ER-to-Golgi trafficking prevented alpha-synuclein toxicity. In particular, they found that one protein, called Ypt1p, which is involved in regulating trafficking could also be switched on to suppress alpha-synuclein toxicity. "Our findings indicated that this ER-to-Golgi trafficking pathway is intimately coupled to the pathology, although in humans there are likely others involved as well, given how many genes we found that modified alpha-synuclein toxicity"
The researchers next studied whether enhancing activity of the mammalian Ytp1p counterpart, called Rab1, suppressed alpha-synuclein toxicity in the fruitfly,the roundworm and in cultures of rat neurons. In all cases they saw significant suppression of toxicity; although not a complete suppression, which confirms that other pathways are affected by alpha-synuclein accumulation.
Lindquist also said the findings give important clues to why dopamine-producing neurons in the brain are the most vulnerable neurons to toxic alpha-synuclein accumulation. The death of such neurons reduces brain dopamine levels, causing the tremors and other symptoms of Parkinson's disease. Dopamine is one of many types of neurotransmitter — chemical signals that one neuron launches at its neighbor to trigger a nerve impulse. "Of all the neurotransmitters, dopamine has a higher potential for being toxic," she said. "Its toxicity is normally prevented in the neuron by sequestration within vesicles for transport from the ER. But a defect in ER trafficking caused by alpha-synuclein accumulation could cause the toxic buildup of dopamine to occur in these neurons."

Lindquist and her colleagues believe their findings will guide the search for new drugs that suppress alpha-synuclein toxicity by enhancing the machinery of ER-to-Golgi transport. Thus, she said, they have already conducted a screen of 150,000 compounds for those with therapeutic potential.
Current treatments for Parkinson's disease do not aim at protecting the dopamine-producing neurons themselves. Rather, the treatments seek to restore dopamine levels in the brain or to treat symptoms of the disease.
Lindquist cautioned that the findings "have not by any means proven that this mechanism of pathology or the compounds that affect it are relevant to humans. However, given the fact that we've found the same results in yeast, flies, worms and rat neurons, I would be very surprised if we didn't find that they were relevant in humans," she said.