SCIENCE NEWS

Nanotechnology Used In Biofuel Process

Dr James Palmer, Associate Professor of chemical engineering at Louisiana Tech University, in collaboration with fellow professors Dr Yuri Lvov, Dr Dale Snow, and Dr Hisham Hegab, has developed the technology that would capitalise the environmental and financial benefits of "biofuels" by using nanotechnology to further improve the cellulosic ethanol processes.

Biofuels are expected to play an important role in search for sustainable fuels and energy production solutions for the future. The demand for fuel in future, however, cannot be satisfied with traditional crops such as sugarcane or corn alone. Emerging technologies are allowing cellulosic biomass (wood, grass, stalks, etc.) to be also converted into ethanol. Cellulosic ethanol does not compete with food production and has the potential to decrease emissions of greenhouse gases (GHG) by 86 per cent over that of today's fossil fuels. Current techniques for corn ethanol reduce greenhouse gases by only 19 per cent.

The nanotechnology processes developed at Louisiana Tech University, allows immobilisation of expensive enzymes used to convert cellulose to sugars, and thus makes them available for reuse several times over thereby significantly reducing the overall cost of the process. Savings estimates range from approximately $32 million for each cellulosic ethanol plant. This process can easily be applied in large scale commercial environments and can immobilise in a wide variety or mixture of enzymes production.

(Source: Science Daily online)

Giant Leap for Nerve Cell Repair

The repair of damaged nerve cells is a major problem in medicine today. A new study by Dr David Colman, Director at the Montreal Neurological Institute and Hospital (The Neuro)

and his research team, is a significant advance towards a solution for neuronal repair. The study featured first to show that nerve cells will grow and make meaningful, functional contacts, or synapses, the specialised junctions through which neurons signal to each other with an artificial component, in this case, plastic beads coated with a substance that encourages adhesion, and attracts the nerve cells.

Many therapies, most still in the conceptual stage, are aiming at to restore the connection between the nerve cell and the severed nerve Fibres that innervate a target tissue, typically muscle. Traditional approaches to therapies would require the re-growth of a severed nerve fibre by a distance of up to one metre in order to potentially restore function. The new approach, according to researchers, bypasses the need to force nerve cells to artificially grow these long distances, and eliminates the demand for two neurons to make a synapse, both of which are considerable obstacles to neuronal repair in a damaged system.

The synapses generated in this research are virtually identical to their natural counterparts except the 'receiving' side of the synapse is an artificial plastic rather than another nerve cell or the target tissue itself. This study is the first that uses these particular devices, to show that adhesion is a fundamental first step in triggering synaptic assembly.

In order to assess function that is transmission of a signal from the synapse they stimulated the nerve cells with electricity, sending the signal, an action potential, to the synapse. By artificially stimulating nerve cells in the presence of dyes, they could see that transmission had taken place as the dyes were taken up by the synapses.

They believe that within the next five years, it will be possible to have a fully functional device that will be able to directly convey natural nerve cell signals from the nerve cell itself to an artificial matrix containing a mini-computer that will communicate wirelessly with target tissues. These results not only provide a model to understand how neurons are formed which can be employed in subsequent studies but also provides hope for those affected and potentially holds promise for the use of artificial substrates in the repair of damaged nerves.

(Source: Science Daily online)

New Mesozoic Mammal

Dr Zhe-Xi Luo, curator of vertebrate paleontology and associate director of science and research at Carnegie Museum of Natural History and his colleagues have discovered a new species of mammal that lived 123 million years ago in Liaoning Province in northeastern China. The newly discovered animal, *Maotherium asiaticus*, comes from famous fossil-rich beds of the Yixian Formation.

Maotherium asiaticus is a symmetrodont, meaning that it has teeth with symmetrically arranged cusps specialised for feeding on insects and worms. It lived on the ground and had a body 15 cm long and weighing approximately 70 to 80 g. By studying all features in this exquisitely preserved fossil, researchers believe *Maotherium* to be more closely related to marsupials and placentals than to monotremes

primitive egg laying mammals of Australia and New Guinea such as the platypus.

This new remarkably well preserved fossil, offers an important insight into how the mammalian middle ear evolved. The discoveries of such exquisite dinosaur age mammals from China provide developmental biologists and paleontologists with evidence of how developmental mechanisms have impacted the morphological evolution of the earliest mammals and sheds light on how complex structures can arise in evolution because of changes in developmental pathways.

Mammals have highly sensitive hearing, far better than the hearing capacity of all other vertebrates, and hearing is fundamental to the mammalian way of life. The mammalian ear evolution is important for understanding the origins of key mammalian adaptations. The intricate middle ear structure of mammals (including humans) has more sensitive hearing, discerning a wider range of sounds than other vertebrates. This sensitive hearing was a crucial adaptation, allowing mammals to be active in the darkness of the night and to survive in the dinosaur dominated Mesozoic.

Mammalian hearing adaptation is made possible by a sophisticated middle ear of three tiny bones, known as the hammer (malleus), the anvil (incus), and the stirrup (stapes), plus a bony ring for the eardrum (tympanic membrane). These mammal middle ear bones evolved from the bones of the jaw hinge in their reptilian relatives. Paleontologists have long attempted to understand the evolutionary pathway via which these precursor jawbones became separated from the jaw and moved into the middle ear of modern mammals.

According to the Chinese and American scientists who studied this new mammal, the middle ear bones of *Maotherium* are partly similar to those of modern mammals; but *Maotherium*'s middle ear has an unusual connection to the lower jaw that is unlike that of adult modern mammals. This middle ear connection, also known as the ossified Meckel's cartilage, resembles the embryonic condition of living mammals and the primitive middle ear of pre-mammalian ancestors. Because *Maotherium asiaticus* is preserved three-dimensionally, paleontologists were able to reconstruct how the middle ear attached to the jaw. This can be a new evolutionary feature, and can be interpreted as having a "secondarily reversal to the ancestral condition," meaning that the adaptation is caused by changes in development.

Modern developmental biology has shown that developmental genes and their gene network can trigger the development of unusual middle ear structures, such as "re-appearance" of the Meckel's cartilage in modern mice. The middle ear morphology in fossil mammal *Maotherium* of the Cretaceous (145-65 million years ago) is very similar to the mutant morphology in the middle ear of the mice with mutant genes. The scientific team studying the fossil suggests that the unusual middle ear structure, such as the ossified Meckel's cartilage, is actually the manifestation of developmental gene mutations in the deep times of Mesozoic mammal evolution.

(Source: Science Daily online)

Smaller and More Efficient Nuclear Battery

Batteries can power anything from small sensors to large systems. While scientists are finding ways to make them smaller but even more powerful, problems can arise when these batteries are much larger and heavier than the devices themselves. Jae Kwon, Assistant Professor of electrical and computer engineering at University of Missouri and his research team, are developing a nuclear energy source that is smaller, lighter and more efficient. To provide enough power, it will need certain methods with high energy density. The radioisotope battery can provide power density that is six orders of magnitude higher than chemical batteries.

Dr Kwon and his research team have been working on building a small nuclear battery, currently the size and thickness of a penny, intended to power various micro/ nanoelectromechanical systems (M/NEMS). Although nuclear batteries can pose concerns, they are safe. However, nuclear power sources have already been safely powering a variety of devices, such as pace-makers, space satellites and underwater systems. His innovation is not only in the battery's size, but also in its semiconductor. Kwon's battery uses a liquid semiconductor rather than a solid semiconductor. The critical part of using a radioactive battery is that when energy is drawn from it, part of the radiation energy can damage the lattice structure of the solid semiconductor. By using a liquid semiconductor, this problem will minimise.

In the future, they hope to increase the battery's power, shrink its size and try with various other materials. According to Kwon, the battery could be thinner than the thickness of human hair.

(Source: Science Daily online)

ALICE: New Aluminium-water Rocket Propellant

Steven Son, associate professor of mechanical engineering at Purdue University and his Research team have developed a new type of rocket propellant made from a frozen mixture of water and "nanoscale aluminium" powder that is more environmentally friendly than conventional propellants and could be manufactured on the Moon, Mars and other water-bearing bodies.

The aluminium-ice, or ALICE, propellant might be used to launch rockets into orbit and for long-distance space missions and also to generate hydrogen for fuel cells. ALICE developed on the Air Force Office of Scientific Research and Pennsylvania State University, was used earlier to launch a 9-foot-tall (2.75 m) rocket. The vehicle reached an altitude of 1,300 feet (396 m). The tiny size of the aluminium particles, which have a diametre of about 80 nanomets, or billionths of a metre, is a key to the propellant's performance. The nanoparticles combust more rapidly than larger particles and enable better control over the reaction and the rocket's thrust.

ALICE provides thrust through a chemical reaction between water and aluminium. As the aluminium ignites, water molecules provide oxygen and hydrogen to fuel the combustion until all of the powder is burned. ALICE might one day replace some liquid or solid propellants, and, when perfected, might have a higher performance

than conventional propellants. It is also extremely safe while frozen because it is difficult to get it ignited accidentally. It could be improved and turned into a practical propellant. Theoretically, it also could be manufactured in distant places like the Moon or Mars instead of being transported at high cost. Findings from spacecraft indicate the presence of water on Mars and the Moon, and water also may exist on asteroids, other moons and bodies in space.

Manufacturers over the past decade have learned, how to make higher quality nano aluminium particles than was possible in the past. The fuel needs to be frozen for two reasons: it must be solid to remain intact while subjected to the forces of the launch and also to ensure that it does not slowly react before it is used. Initially a paste, the fuel is packed into a cylindrical mold with a metal rod running through the centre. After it is frozen, the rod is removed, leaving a cavity running the length of the solid fuel cylinder. A small rocket engine above the fuel is ignited, sending hot gasses into the central hole, causing the ALICE fuel to ignite uniformly.

Other researchers previously have used aluminium particles in propellants, but those propellants usually also contained larger, micron-size particles, whereas the new fuel contained pure nanoparticles. Future work will focus on perfecting the fuel and also may explore the possibility of creating a gelled fuel using the nanoparticles. Such a gel would behave like a liquid fuel, making it possible to vary the rate at which the fuel is pumped into the combustion chamber to throttle the motor up and down and increase the vehicle's distance. A gelled fuel also could be mixed with materials containing larger amounts of hydrogen and then used to run hydrogen fuel cells in addition to rocket motors.

The research is helping to train a new generation of engineers to work in academia, industry, for NASA and the military. It is unusual for students to get this kind of advanced and thorough training to go from a basic-science concept all the way to a flying vehicle that is ground tested and launched. This is the whole spectrum.

(Source: Science Daily online)

Does Moon have Water!

According to Dr Vincent Eke, in the Institute for Computational Cosmology, at Durham University, Crashing a rocket into the Moon will create "one more dimple" on the lunar surface and could find water ice on Earth's nearest neighbour.

The Lunar Crater Observation and Sensing Satellite (LCROSS) and its Centaur rocket was made to smash into a crater in the Cabeus region of the Moon's South Pole in the second week of October 2009. This site has been chosen in view of higher concentration of hydrogen found in the region which could be due to the hydrogen in water present there as water ice. The rocket has roughly the mass of a Transit van and it will hit the Moon at about 5,600 miles per hour (9 000 km/h). The energy of the collision has been estimated to be roughly equivalent to two tonnes of TNT. It has been estimated that the impact would hurl approximately 350 tonnes of material up from moon's surface and will be propelled into the sunlight so that scientists can study its composition by using ground-based telescopes.

It may be recalled that in September 2009, India's Chandrayaan-1 probe had found that particles that

make up the Moon's soil are coated with small amounts of H_2O. It is contemplated that this water in the form of ice could be found in the frozen confines of the Moon's polar craters where temperatures are in the vicinity of minus 170 degrees Celsius. If it is so, then the Chandrayaan-1 data would imply that the top metre of the surface in these craters holds about 200,000 million litre of water.

According to Dr Eke, water ice could be stable for billions of years on the Moon provided that it is cold enough. If ice is present in the permanently shaded lunar craters of the Moon then it could potentially provide a water source for the eventual establishment of a manned base on the Moon. Such a base could be used as a platform for exploration into the further reaches of our solar system.

(Source: Science Daily online)

Nobel Prize in Physics: Creators of Optical Fibre Communication and CCD Image Sensor

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2009 with one half to Charles K. Kao, Standard Telecommunication Laboratories, Harlow, UK, and Chinese University of Hong Kong "for groundbreaking achievements concerning the transmission of light in fibres for optical communication, and the other half jointly to Willard S. Boyle and George E. Smith, Bell Laboratories, Murray Hill, NJ, USA "for the invention of an imaging semiconductor circuit CCD sensor".

This year's Nobel Prize in Physics is awarded for two scientific achievements that have helped to shape the foundations of today's networked societies. They have created many practical innovations for everyday life and provided new tools for scientific exploration.

In 1966, Charles K. Kao made a discovery that led to a breakthrough in fibre optics. He carefully calculated how to transmit light over long distances via optical glass fibres. With a fibre of purest glass it would be possible to transmit light signals over 100 kilometres, compared to only 20 metres for the fibres available in the 1960s. Kao's enthusiasm inspired other researchers to share his vision of the future potential of fibre optics. The first ultrapure fibre was successfully fabricated just four years later, in 1970.

Today optical fibres make up the circulatory system that nourishes our communications society. These low-loss glass fibres facilitate global broadband communication such as the Internet. Light flows in thin threads of glass, and it carries almost all of the telephony and data traffic in each and every direction. Text, music, images and video can be transferred around the globe in a split second.

If we were to unravel all of the glass fibres that wind around the globe, we would get a single thread over one billion kilometres long – which is enough to encircle the globe more than 25 000 times – and is increasing by thousands of kilometres every hour.

A large share of the traffic is made up of digital images, which constitute the second part of the award. In 1969 Willard S. Boyle and George E. Smith invented the first successful imaging technology using a digital sensor, a CCD (Charge-Coupled Device). The CCD technology makes use of the photoelectric effect, as theorised by Albert

Einstein and for which he was awarded the 1921 year's Nobel Prize. By this effect, light is transformed into electric signals. The challenge when designing an image sensor was to gather and read out the signals in a large number of image points, pixels, in a short time.

The CCD is the digital camera's electronic eye. It revolutionised photography, as light could now be captured electronically instead of on film. The digital form facilitates the processing and distribution of these images. CCD technology is also used in many medical applications, e.g. imaging the inside of the human body, both for diagnostics and for microsurgery.

Digital photography has become an irreplaceable tool in many fields of research. The CCD has provided new possibilities to visualise the previously unseen. It has given us crystal clear images of distant places in our universe as well as the depths of the oceans.

(Source: Science Daily online)

Physicist Makes New High-resolution Panorama of Milky Way

Cobbling together 3000 individual photographs, a physicist Axel Mellinger, a professor at Central Michigan University, has made a new high-resolution panoramic image of the full night sky, with the Milky Way galaxy as its centrepiece.

This panorama image shows stars 1000 times fainter than the human eye can see, as well as hundreds of galaxies, star clusters and nebulae. Its high resolution makes the panorama useful for both educational and scientific purposes.

Mellinger spent 22 months and travelled over 26,000 miles (41, 800 km) to take digital photographs at dark sky locations in South Africa, Texas and Michigan. Each photograph is a two-dimensional projection of the celestial sphere. As such, each one contains distortions, in much the same way that flat maps of the round Earth are distorted. In order for the images to fit together seamlessly, those distortions had to be accounted for that Mellinger used a mathematical model and hundreds of hours in front of a computer.

Due to artificial light pollution, natural air glow, as well as sunlight scattered by dust in our solar system, it is virtually impossible to take a wide-field astronomical photograph that has a perfectly uniform background. To fix this, he used data from the Pioneer 10 and 11 space probes. The data allowed him to distinguish star light from unwanted background light. He could then edit out the varying background light in each photograph. That way they would fit together without looking patchy.

The result is an image of our home galaxy that no star-gazer could ever see from a single spot on earth. Mellinger plans to make the giant 648 megapixel image available to planetariums around the world.

(Source: Science Daily online)

New Evidence on Formation of Oil and Gas

Scientists in Washington, D.C. are reporting laboratory evidence supporting the possibility that some of Earth's oil and natural gas may have formed in a way much different than the traditional process.

According to Anurag Sharma and colleagues the traditional process involves biological process i.e. prehistoric plants died and changed into oil and gas while sandwiched between layers of rock in the hot, high-pressure environment deep below Earth's surface. Some scientists, however, believe that oil and gas originated in other ways, including chemical reactions between carbon dioxide and hydrogen below the Earth's surface.

The genesis of the new study lies on the description of the process suggested by famous Russian chemist Dimitri Mendeleev some time around 1877. Taking their clue from this the researchers combined ingredients for this so-called abiotic synthesis of methane, the main ingredient in natural gas, in a diamond-anvil cell and monitored *in-situ* the progress of the reaction. The diamond anvils can generate high pressures and temperatures similar to those that occur deep below Earth's surface and allow for *in-situ* optical spectroscopy at the extreme environments.

The results strongly suggest that some methane could form strictly from chemical reactions in a variety of chemical environments. This study further highlights the role of reaction pathways and fluid immiscibility in the extent of hydrocarbon formation at extreme conditions simulating deep subsurface.

(Source: Science Daily online)

Mathematical Model to Explain How the Brain Might Stay in Balance

The human brain is made up of 100 billion of neurons, acting like live wires, which must be kept in delicate balance to stabilise the world's most magnificent computing organ. Too much excitement and the network will slip into an apoplectic, uncomprehending chaos. Too much inhibition and it will flat line. Marcelo O. Magnasco, Head of the Laboratory of Mathematical Physics at The Rockefeller University, and his colleagues have developed a new mathematical model that describes how the trillions of interconnections among neurons could maintain a stable but dynamic relationship that leaves the brain sensitive enough to respond to stimulation without veering into a blind seizure.

How such a massively complex and responsive network, such as the brain, can balance the opposing forces of excitation and inhibition? According to Magnasco, neurons function together in localised groups to preserve stability. The defining characteristic of system is that the unit of behaviour is not the individual neuron or a local neural circuit but rather groups of neurons that can oscillate in synchrony. The result is that the system is much more tolerant to faults, individual neurons may or may not fire, individual connections may or may not transmit information to the next neuron, but the system keeps functioning.

Magnasco's model differs from traditional models of neural networks, which assume that each time a neuron fires and stimulates an adjoining neuron, the strength of the connection between the two increases. This is called the Hebbian theory of synaptic plasticity and is the classical model for learning. But the Magnasco system is anti-Hebbian. If the connections among any groups of neurons are strongly oscillating together, they are weakened because they threaten homeostasis. Instead of trying to learn, our neurons are trying to forget. One advantage of

this anti-Hebbian model is that it balances a network with a much larger number of degrees of freedom than classical models can accommodate, a flexibility that is likely required by a computer as complex as the brain.

Magnasco theorises that the connections that balance excitation and inhibition are continually flirting with instability. He compares the behaviour of neurons to a network of indefinitely large number of public address systems tweaked to that critical point at which a flick of the microphone brings on a screech of feedback that then fades to quiet with time.

This model of a balanced neural network is abstract; it does not try to recreate any specific neural function such as learning. But it requires only half of the network connections to establish the homeostatic balance of exhibition and inhibition crucial to all other brain activity. The other half of the network could be used for other functions that may be compatible with more traditional models of neural networks, including Hebbian learning.

Developing a systematic theory of how neurons communicate could provide a key to some of the basic questions that researchers are exploring through experiments. This model could be one part of a better understanding. It has a large number of interesting properties that make it a suitable substrate for a large-scale computing device.

(Source: Science Daily online)

Genomes of Biofuel Yeasts Mapped

As global temperatures and energy costs continue to soar, renewable sources of energy will be key to a sustainable future. An attractive replacement for gasoline is biofuel, and in two studies scientists have analysed the genome structures of bioethanol producing microorganisms, uncovering genetic clues that will be critical in developing new technologies needed to implement production on a global scale.

Bioethanol is produced from the fermentation of plant material, such as sugar cane and corn, by the yeast *Saccharomyces cerevisiae*, just as in the production of alcoholic beverages. However, yeast strains thriving in the harsh conditions of industrial fuel ethanol production are much harder than their beer brewing counterparts, and surprisingly little is known about how this yeast adapted to the industrial environment. If researchers can identify the genetic changes that underlie this adaptation, new yeast strains could be engineered to help shift bioethanol production into high gear across the globe.

Two studies have taken a major step toward this goal, identifying genomic properties of industrial fuel yeasts that likely gave rise to more robust strains. In one of the studies, researcher Lucas Argueso and colleagues from Duke University at USA and Brazil have sequenced and analysed the structure of the entire genome of strain PE-2, a prominent industrial strain in Brazil. Their work revealed that portions of the genome are plastic compared to other yeast strains, specifically the peripheral regions of chromosomes, where they observed a number of sequence rearrangements.

Interestingly, these chromosomal rearrangements in PE-2 amplified genes involved in stress tolerance, which likely contributed to the adaptation of this strain to the industrial

environment. As PE-2 is amenable to genetic engineering, the authors believe that their work on PE-2 will open the door to development of new technologies to boost bioethanol production.

In a second study conducted by Boris Stambuk from Stanford University, USA and Gavin Sherlock Brazil, the two scientists have also analysed the genome structure of industrial bioethanol yeasts, searching for variations in the number of gene copies in five strains employed in Brazil, including PE-2. Stambuk and colleagues found that all five industrial strains studied harbour amplifications of genes involved in the synthesis of vitamins B6 and B1 compounds critical for efficient growth and utilisation of sugar.

The group experimentally demonstrated that the gene amplifications confer robust growth in industrial conditions, indicating that these yeasts are likely adapted to limited availability of vitamins in the industrial process to gain a competitive advantage. Furthermore, the researchers suggest that this knowledge can be utilised to engineer new strains of yeast capable of even more efficient bioethanol production, from a wider range of agricultural stocks.

It is evident that an expanding human population will require more energy that exerts less impact on the environment, and the information gained from these genomic studies of industrial bioethanol yeasts will be invaluable as biofuel researchers optimise production and implement the technology worldwide.

(Source: Science Daily online)

'Ultra-primitive' Particles Found In Comet Dust

Interplanetary dust particles with presolar grains: Scanning electron images of two dust particles E1 (panel A) and G4 (B) and secondary ion mass spectrometry isotopic ratio maps (C—D). Oxygen isotope maps of particles E1 (C) and G4 (D) show four and seven isotopically anomalous regions, indicated by circles, which have been identified as presolar grains. The scale bars are 2 microns.

According to Larry Nittler and his colleagues, Department of Terrestrial Magnetism at Carnegie Institution, dust samples collected by high-flying aircraft in the upper atmosphere have yielded an unexpectedly rich trove of relics from the ancient cosmos. The stratospheric dust includes minute grains that had formed inside stars that lived and died long before the birth of our sun, as well as material from molecular clouds in interstellar space. This ultra-primitive material likely wafted into the atmosphere after the Earth passed through the trail of an Earth crossing comet in 2003.

At high altitudes, most dust in the atmosphere comes from space, rather than the Earth's surface. Thousands of tons of interplanetary dust particles (IDPs) enter the atmosphere each year. The only known cometary samples are those that were returned from comet 81P/Wild 2 by the Stardust mission. The Stardust mission used a NASA-launched spacecraft to collect samples of comet dust, returning to Earth in 2006.

Comets are thought to be repositories of primitive, unaltered matter left over from the formation of the solar system. Material held for eons in cometary ice has largely escaped the

heating and chemical processing that has affected other bodies, such as the planets. However, the Wild 2 dust returned by the Stardust mission included more altered material than expected, indicating that not all cometary material is highly primitive.

The IDPs used in the current study were collected by NASA aircraft after the Earth passed through the dust trail of comet Grigg-Skjellerup. The research team comprising Nittler, Henner Busemann, Ann Nguyen, George Cody, analysed a sub-sample of the dust to determine the chemical, isotopic and micro-structural composition of its grains. They are very different from typical IDPs. They are more primitive, with higher abundances of material whose origin predates the formation of the solar system. The distinctiveness of particles plus the timing of their collection after the Earth's passing through the comet trail, point to their source being the Grigg-Skjellerup comet.

This is exciting because it allows us to compare on a microscopic scale in the laboratory dust particles from different comets. We can use them as tracers for different processes that occurred in the solar system four-and-a-half billion years ago.

The biggest surprise for the researchers was the abundance of so-called pre-solar grains in the dust sample. Pre-solar grains are tiny dust particles that formed in previous generations of stars and in supernova explosions before the formation of the solar system. Afterwards, they were trapped in our solar system as it was forming and are found today in meteorites and in IDPs. Pre-solar grains are identified by having extremely unusual isotopic compositions compared to anything else in the solar system.

But pre-solar grains are generally extremely rare, with abundances of just a few parts per million in even the most primitive meteorites, and a few hundred parts per million in IDPs. In the IDPs associated with comet Grigg-Skjellerup they are up to the per cent level. This is tens of times higher in abundance than other primitive materials.

Also surprising is the comparison with the samples from Wild 2 collected by the Stardust mission. Their samples seem to be much more primitive, much less processed, than the samples from Wild 2. This may indicate that there is a huge diversity in the degree of processing of materials in different comets.

(Source: Science Daily online)

New Hydrogen Storage Method

This schematic shows the structure of the new material, $Xe(H_2)_7$. Freely rotating hydrogen molecules (red dumbbells) surround xenon atoms (yellow). (Credit: Image courtesy of Nature Chemistry)

Dr Maddury Somayazulu, a research scientist of Geophysical Laboratory at Carnegie Institution and his research team have found for the first time that high pressure can be used to make a unique hydrogen storage material. The discovery paves the way for an entirely new way to approach the hydrogen storage problem.

They found that the normally unreactive, noble gas xenon combines with molecular hydrogen (H_2) under pressure to form a previously unknown solid with unusual bonding chemistry. The experiments are the first time that has combined these elements to form a stable compound. The

discovery debuts a new family of materials, which could boost new hydrogen technologies.

Xenon has some intriguing properties, including its use as an anesthesia, its ability to preserve biological tissues, and its employment in lighting. Xenon is a noble gas, which means that it does not typically react with other elements.

According to Maddury Somayazulu, elements change their configuration when placed under pressure, sort of like passengers readjusting themselves as the elevator becomes full. They subjected a series of gas mixtures of xenon in combination with hydrogen to high pressures in a diamond anvil cell. At about 41,000 times the pressure at sea level (1 atm), the atoms became arranged in a lattice structure dominated by hydrogen, but interspersed with layers of loosely bonded xenon pairs. When we increased pressure, like tuning a radio, the distances between the xenon pairs changed the distances contracted to those observed in dense metallic xenon.

The researchers imaged the compound at varying pressures using X-ray diffraction, infrared and Raman spectroscopy. When they looked at the xenon part of the structure, they realised that the interaction of xenon with the surrounding hydrogen was responsible for the unusual stability and the continuous change in xenon-xenon distances as pressure was adjusted from 41,000 to 255,000 atmospheres.

They were taken off guard by both the structure and stability of this material by changes in electron density at different pressures using single-crystal diffraction. As electron density from the xenon atoms spreads towards the surrounding hydrogen molecules, it seems to stabilise the compound and the xenon pairs.

It is very exciting to come up with new hydrogen rich compounds, not just for our interest in simple molecular systems, but because such discoveries can be the foundation for important new technologies. This hydrogen-rich solid represents a new pathway to forming novel hydrogen storage compounds and the new pressure induced chemistry opens the possibility of synthesising new energetic materials.

(Source: Science Daily online)

Bang on: Success for collider as first atom is smashed

In Geneva, two circulating beams produced the first particle collisions in the world's biggest atom smasher, the Large Hadron Collider (LHC), three days after its restart.

According to director general Rolf Heuer of European Organisation for Nuclear Research (CERN), two beams circulating simultaneously led to collisions at all four detection points. According to scientists it is a great achievement to have come this far in so short a time. In the control rooms of the collider and of the four giant particle detectors, built and staffed by thousands of physicists who have the job of interpreting the data from the beginning of time, there were all-round cheers.

Scientists are looking to the collider inside a 27 km tunnel on the Franco Swiss border to mimic the conditions that followed the Big Bang and help explain the origins of the universe. The project intended to study proton-proton collisions

to create conditions following the big bang, is a global Endeavour. CERN has received support from countries around the world, including India, in getting the LHC up and running again.

The LHC is back

On 20 November, 2009, particle beams were once again circulating in the world's most powerful particle accelerator, CERN's Large Hadron Collider (LHC). A clockwise circulating beam was established at 10 pm on that day. This has been an important milestone on the road towards first physics experiment at the LHC, expected in 2010.

It may be recalled that the initial efforts to circulate the beams at LHC in September 2008 was abandoned within nine days, as it suffered a serious malfunction. A failure in an electrical connection led to serious damage, and CERN has to spend over a year in repairing and consolidating the machine to ensure that such an incident cannot happen again.

Decommissioning the LHC began in the summer of 2010, and since then successive milestones have regularly been passed. On October, 8, the LHC reached its operating temperature of 1.9 Kelvin, or about -271 °C. Particles were injected on 23 October, but not circulated. On 7 November, a beam was steered through three octants of the machine and circulating beams were reestablished. The next expected important milestone has been low energy collisions. These would give the experimental collaborations their first collision data, enabling important calibration work to be carried out. This is significant, that all the data they have recorded comes from cosmic rays. Ramping the beams to high energy followed in preparation for collisions at 7 TeV (3.5 TeV per beam) and the first collision between circulating beams at LHC was accomplished after three days of its restart.

For the first time on 23 November 2009, the LHC circulated two beams simultaneously, allowing the operators to test the synchronisation of the beams and giving the experiments their first chance to look for proton-proton collisions. With just one bunch of particles circulating in each direction, the beams can be made to cross in up to two places in the ring. From early in the afternoon, the beams were made to cross at points 1 and 5, home to the ATLAS and CMS detectors, both of which were on the look out for collisions. Later, beams crossed at points 2 and 8, ALICE and LHCb.

Beams were first tuned to produce collisions in the ATLAS detector, which recorded its first candidate for collisions at 14:22 on that day. Later, the beams were optimised for CMS. In the evening, ALICE had the first optimisation, followed by LHCb.

These developments come just three days after the LHC restart, demonstrating the excellent performance of the beam control system. Since the start-up, the operators have been circulating beams around the ring alternately in one direction and then the other at the injection energy of 450 GeV. The beam lifetime has gradually been increased to 10 hours, and on November 23, 2009, the beams were circulating simultaneously in both directions, still at the injection energy.

This undoubtedly marks the beginning of a fantastic era of physics and hopefully discoveries after 20 years' work by the international community to build a machine and detectors of unprecedented

complexityand performance.The events so far mark the start of the second half ofthis incredible voyage of discovery ofthe secrets of nature.

Next on the schedule is an intense commissioning phase aimed at increasing the beam intensity and accelerating the beams. All being well, the LHC should reach 1.2 TeV per beam by the end of 2009 and would have provided good quantities of collision data for the experiments' calibrations.

(Source: CERN Press release)

Harnessing Waste Heat from Laptop Computers, Cell Phones May Double Battery Time

In everything from computer processor chips to car engines to electric powerplants, the need to get rid of excess heat creates a major source of inefficiency. But new research points the way to a technology that might make it possible to harvest much of that wasted heat and turn it into usable electricity. (Credit: iStockphoto/ Evgeny Kuklev)

The production and usage of electric energy is always associated with some loss of energy in the form of heat. In everything from computer processor chips to car engines to electric power plants, the need to get rid of excess heat creates a major source of inefficiency. But new research might lead to a technology that may make it possible to harvest much of that wasted heat and turn it into usable electricity. That kind of waste energy harvesting might, for example, lead to cellphones with double the talk time, laptop computers that can operate twice as long before needing to be plugged in, or power plants that put out more electricity for a given amount of fuel.

According to Peter Hagelstein, an associate professor of electrical engineering at MIT, USA, existing solid-state devices are not very efficient as far as conversion of heat into electricity is concerned. The major objective of the present research carried out by Hagelstein, with his research student Dennis Wu, has been to find as to how close realistic technology could come to the theoretical limits for the efficiency of such conversion. Theory says that such conversion of energy can never exceed a specific value called the Carnot Limit, based on a 19th-century formula for determining the maximum efficiency that any device can achieve in converting heat into work. But current commercial thermoelectric devices only achieve about one-tenth of that limit. In earlier experiments involving a different new technology, thermal diodes, Hagelstein worked with Yan Kucherov at Naval Research Laboratory, and coworkers to demonstrate the efficiency as high as 40 per cent of the Carnot Limit. Moreover, the calculations show that this new kind of system could ultimately reach as much as 90 percent of that ceiling.

Hagelstein and coworkers started from scratch rather than trying to improve the performance of existing devices. They carried out their analysis using a very simple system in which power was generated by a single quantum dot device, a type of semiconductor in which the electrons and holes, carry the electrical charges in the device, are very tightly confined in all three dimensions. By controlling all aspects of the device, they hoped to better understand how to design the ideal thermal-to-electric converter.

According to Hagelstein, with present systems it is possible to efficiently convert heat into

electricity, but with very little power. It is also possible to get plenty of electrical power. You either get high efficiency or high throughput, but the team found that using their new system, it would be possible to get both at once. A key to the improved throughput was reducing the separation between the hot surface and the conversion device. A recent research paper by MIT professor Gang Chen reported on an analysis showing that heat transfer could take place between very closely spaced surfaces at a rate that is orders of magnitude higher than predicted by theory.

The work on the development of this new technology is already in process. This technology could produce a ten-fold improvement in throughput power over existing photovoltaic devices.

The first applications are likely to be in high-value systems such as computer chips, he says, but ultimately it could be useful in a wide variety of applications, including cars, planes and boats. A lot of heat is generated in transport vehicles and a lot of it is lost. If it could be recovered, the transportation technology is going to get more energy efficient.

(Source: Science Daily online)

Crystalline sponge capture CO_2

To sequester carbon dioxide as part of any climate change mitigation strategy, the gas first has to be captured from the flue at a power plant or other source. The next step is just as important: the CO_2 has to be released from whatever captured it so that it can be pumped underground or otherwise stored for the long term. That second step can be costly from an energy standpoint. Materials currently used to capture CO_2 have to be heated to release the gas. But chemists at University of California, Los Angeles, have claimed that a new class of materials developed by them, called metal-organic frameworks (MOFs), hold promise for carbon capture. In the study, Omar Yaghi describes the performance of one MOF, which can free moss of the CO_2 it captures at room temperature. Yaghi described a metal-organic framework as a "crystalline sponge", a hybrid lattice of organic compounds and metal atoms that has a huge internal surface area where gas molecules can be absorbed.

The MOF used in the study contains magnesium atoms, which make just the right environment for binding carbon dioxide. In experiments, the material separated out CO_2 while allowing methane to pass. What was really surprising, though, was that at room temperature 87 per cent of the CO_2 could be released.

(Source: Times of India)

Indians Succeed in Complete Mapping of the Human Genome: Genome *Patri* of an Indian Male

It took the US Human Genome Project more than a decade and $500 million to sequence genes drawn from several volunteers. A team of Indian scientists at the Institute of Genomics and Integrative Biology (IGIB), New Delhi, of the Council for Scientific and Industrial Research (CSIR) has reported mapping of the entire genome of a 52-year-old Indian male from Jharkhand in

just 10 months, at a cost of $30,000 or Rs 13.5 lakh. With this achievement, India joins the ranks of the few countries – the US, UK, Canada, China and South Korea, which have successfully sequenced the human genome. Earlier, CSIR scientists had mapped the genetic diversity of the Indian population and also completed the sequencing of genome of the zebra fish, commonly used in laboratories as a model for researching human diseases.

There are greater chances of arriving at a better understanding of the genetic make-up and peculiarities of local populations with countries creating their own DNA sequences; as such knowledge is crucial in comprehending country specific health trends and genetic traits that would otherwise remain largely a mystery. This will enrich knowledge of the different genetic variations that occur in different population groups as well as enable the identification of genes that predispose some to certain diseases. The male, whose genome was decoded by CSIR scientists, is predisposed to heart disease and cancer, and this information has been gleaned from the sequencing of his DNA. The research finding inter alias suggests that Indians are more susceptible to not just for heart diseases, but certain kinds of cancer and mental disorders as well. The technology, therefore, would be invaluable in diagnostics and could be useful in medical treatment as well. Drugs designed to target the affected genes could be formulated, though at present to do so would involve high costs and such an option would be out of reach of the average patient. However, as with all sci-tech breakthroughs, costs are bound to come down – as it has in the case of the genome mapping technology and various computer models – and it is only a matter of time before they become affordable.

According to Sridhar Sivasubbu, who led the project along with Vinod Scaria, they have accomplished mapping of entire genome in a few months whereas the first human genome project which associated scientists from the US, UK, France, Germany, Japan and China took nearly 13 years, from 1990 to 2003. Of course, the first time is always tough, as every attempt involves trial and error, opined Sivasubbu while elaborating on their work. However, it wasn't easy for the two scientists who worked up to 18 hours a day in the lab. We would never have been there, never done it without having a totally new set of analytical and computational skills, which has been one of the biggest challenges before us, asserts Sivasubbu. Once this was attained, there was no looking back. According to Scaria since the genome technology was readily available to them, it took much less time. In spite of this, Sivasubbu and Scaria toiled for long hours on their mission to map the 310 crore (3.1 billion) base pairs that constituted the Jharkhand man's DNA utilising the facilities of a supercomputer, capable of analysing data at the speed of four trillion operations per second, that their institute had acquired in 2006. Although the supercomputer speeded up analysis by more than 500 times compared to ordinary computers, scientists had to perform the manual work of immobilising the sample on glass slide, adding one nucleotide at a time and photographing it using a high-resolution digital camera. Each nucleotide was identified by peculiar colour it emits.

Law and ethical resolutions tend to lag behind implementation of scientific and technological advances, and the relatively new field of DNA sequencing is no exception. What if an individual's genome *patri* (horoscope) were accessible to employers and insurance companies who might use the information against the employee or clients? Should an individual choose to reveal details of his genetic 'horoscope' to his family and friends or keep it private? Would the knowledge impact the individual's own perspective of life and how he lives it? There are plenty of issues that may crop up for debate, especially since predisposition to a disease does not mean it would actually manifest in the person.

(Source: Times of India)

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