Innovations

Composite laptop cover
In partnership with Performance Materials Corporation (PMC), RocTool has launched what is said to be the first complete composite laptop cover. The composite cover was created by combining RocTool’s Cage System and PMC’s CFRT (continuous fibre reinforced thermoplastic) technologies. Using this new approach, a lightweight laptop cover can be produced in approximately two minutes at a competitive price with what is said to be excellent surface quality and superior impact resistance compared with the magnesium or plastic currently used. This extremely short cycle opens a new potential market for the composites industry that may extend beyond laptops into new sectors and industries. Thomas Smith, CEO of PMC, commented that the Cage System technology provides a critical missing link in making high volume, complex CFRT parts. ‘These technologies provide for advanced composite performance approaching the detail and speed of injection moulding. The processes are also amenable to a high level of automation.’ One potential application is in consumer electronics where thin walls and high detail are required, including closed section shapes.

RocTool and PMC have signed an Exclusive Development License Agreement for Laptop applications. Further information at www.roctool.com or www.performancematerials.com.

Zirconia coating enhances turbo efficiency
A ceramic thermal barrier coating has allowed Litchfield Imports, based in Tewkesbury, UK, to improve the performance of its new Subaru Impreza STI Type-20. Litchfield, an importer and modifier of Japanese performance cars, has previously applied the coating in its STI Type-25.

The zirconia based thermal coating developed by Zircotec is used for protection and to manage the heat around the vehicle’s twinscroll turbocharger. The enhanced heat management provided by the coating allows the car’s twinscroll turbo spool to reach speeds of up to 500–750 rpm sooner than would otherwise be the case. ‘With the coating applied to the turbo’s double exhaust ports, more heat is retained in the system. As a result the turbo spools faster and lag is reduced’, explains Managing Director, Iain Litchfield.

Other benefits are said to include reduced underbonnet temperatures and crisper throttle response. As the turbo is sited underneath the intercooler, heat is retained in the turbocharger and does not affect the operation of the intercooler and other components. Litchfield’s design is available as a bolt-on replacement for its Japanese based imports and for 2003 model year Subaru Imprezas onwards.

Further information at www.litchfieldimports.co.uk.

Small scale wind turbine
Finnish company PEM-Energy Oy has launched a wind turbine for use on houses and small offices. The MyPower turbine has a nominal output of 2 kW, a mast height of 5 m and a turbine diameter of 4 m. It can generate 5–12 MWh of energy a year and up to 15 MWh per year on windy shores.

MyPower turbine is connected to a boiler electrical resistor allowing energy to be stored in the water mass as heat
Telene will be used to produce the small-scale wind turbines. These polymeric materials are widely used for production of truck and agricultural vehicle body panels, cell covers for chlor-alkali plants, domestic waste water treatment units and large waste containers. Among many other attractive properties, Telene dicyclopentadiene (DCPD) resins can withstand hostile environments, are suitable for large to very large parts, can be painted and offer design freedom. ’Compared with alternative materials, Telene has a better quality surface. It retains its shape well, lends itself to moulding into integrated structural parts and withstands the test of time and difficult weather conditions better than other plastic materials’, explains Juhani Pykkänen, Professor of Production Technology at the University of Oulu, Finland. The closed mould process used to produce the turbine parts reduces the release of volatile organic compounds relative to GRP hand-lay-up or spray-up processes.

Further information at www.mypower.fi or www.telene.com.

Self-gripping fasteners
The inter-mold technology from Aplix, which allows hooks to be injection moulded directly into plastic parts, has allowed the development of a new generation of self-gripping fasteners. The hooks can be designed in any shape or size and do not need to be restricted to a particular location on the component.

‘We are excited about using the simplicity and integrated look of inter-mold in new products. It offers great design flexibility and high performance in an infinitively adjustable fastening system,’ says Mario Turchi, Principal Director of ION Design. The hooks are moulded during a standard injection cycle (one-shot), so that they are an integral part of a product. A shaped insert mounted into the injection mould is used to enable hook formation. The hooks temporarily straighten on ejection from the mould but take their original shape after the demoulding process. Four hook designs have been developed: standard, dual, micro- and twin hook. Which is chosen is based on the application and nature of the woven, non-woven or knitted loop materials used for engagement. Adhesives are not required for hook attachment to the component, thereby providing environmental benefits.

The inter-mold technology is compatible with a range of resins, including polypropylene, polyethylene,
polyamide, polyacetal, thermoplastic elastomers and PEEK. Since hook and finished product are made of the same plastic, they will have the same properties, for example, resistance to high temperature and specific chemicals. This also makes recycling of the product easier. This technology has applications in the automotive (door panels), medical (cervical collar), cleaning, civil engineering (screws, clips) and boating sectors.

For further information visit: www.aplix.com.

Oakland launches nanotech institute

It was recently announced that a NanoTech Research and Development Institute will be launched at the Oakland University campus in Rochester, Michigan. It is expected that the Institute will serve as a focal point of nanotechnology research in nanoscale science and engineering, with activity in sectors including health care, energy, manufacturing, computer technology and agriculture. Dr T. C. Yih will lead the NanoTech Institute as Founding Director.

Collaborative partnerships will form an important aspect of the Institute’s activities. A partnership is already in place with Octillion Corp., Washington, DC, which so far has donated nearly $0.73m in grants and sponsorship. Research at Octillion focuses on the development of alternative and renewable energy technologies. An additional partnership is with the Michigan based company, Nanorex, which specialises in the development of nano-mechanical engineering tools for the design and synthesis of complex DNA nano-structures.

For further information contact Dr T.C. Yih, Oakland University NanoTech Institute, Rochester, MI, USA, email yih@oakland.edu.

WC coating for titanium

Components manufactured from titanium can now benefit from a specially tailored variant of the wear, abrasion and chemical resistant Hardide tungsten carbide based coating. Produced by a low temperature chemical vapour deposition (CVD) process, Hardide coatings are applied to steel and other materials, to enhance toughness and chemical resistance and to provide reduce friction in service.

Titanium suffers from intense galling under tribological conditions, which means that coating methods such as surface oxidation, spray coatings and plating are not effective. However, no galling was observed for titanium coated with the new titanium specific coating. As Dr Yuri Zhuk, Technical Director of Hardide commented: ‘Titanium is often used in performance critical, high load bearing and weight sensitive environments. Hardide demonstrates strong coating adhesion and doesn’t require grinding to finish. The ability to coat titanium with Hardide will open up a range of new possibilities for engineering design.’

UK based Hardide Coatings Ltd has recently successfully completed stage 1 of the aerospace industry standard AS9100 certification with full certification scheduled for late 2009.

Current applications are in the oil and gas and aerospace sectors, valves and pump manufacturing and high end engineering.

For further information contact Dr Yuri Zhuk, Technical Director, Hardide Coatings Ltd, email yzhuk@hardide.com or visit: www.hardide.com.

Low temperature nanotube fabrication

Georgia Institute of Technology has ordered a nanomaterial growth tool from Surrey NanoSystems. The NanoGrowth 1000n equipment with automated control incorporates a low temperature growth module designed to allow the precise, repeatable growth of carbon nanotubes (CNTs) and related nanomaterials. A processing temperature of ~350°C has been shown to support growth on flexible polymer substrates, and it is hoped that the same can be achieved with even lower temperatures, opening up new application areas for CNTs.

The NanoGrowth tool arose from research into CNT fabrication at the Advanced Technology Institute, University of Surrey, UK. The growth achieved at temperatures below 400°C makes the system suitable for growing nanomaterials on fabricated silicon structures for insulation or conduction purposes. Its heat transfer system allows processing temperatures to increase steadily at a rapid rate of 300 K s⁻¹. This minimises the danger of the ultra-finely spaced catalyst material deposits agglomerating during heating, so supporting the growth of highly integrated arrays and shapes.

One of Georgia Tech’s research aims is to investigate the development of carbon nanotube heatsink structures to manage heat conduction and dissipation capability. Thermal management may offer a solution to a prime cause of silicon chip failure and so support further advances in integration density and performance. Dr Baratunde Cola, Assistant Professor at the George W. Woodruff School of Mechanical Engineering, has set up the NEST research group (NanoEngineered Systems and Transport Research), part of Georgia Tech’s Microelectronics Research Centre. NEST’s aims include developing technology for cleaner energy solutions, smaller and more affordable electronics, and general improvements to global living standards. The first target substrates for the NanoGrowth system include the high performance polyimide film Kapton.

Further information from: Surrey NanoSystems, Euro Business Park, Building 24, Newhaven BN9 9QD, UK, tel. +44 (0) 1273 515899, email enquiries@surreynanosystems.com, Internet http://www.surreynanosystems.com.

Modified biofilm resistant surfaces

Bacteria colonise almost any surface exposed to liquids and nutrients, producing a biofilm which protects the cells within it and facilitates communication among them through biochemical signals. Free-floating bacteria can anchor themselves to a surface using cell adhesion structures such as pili. More cells arrive and adhere to earlier colonists, and begin to produce the extracellular matrix that holds the biofilm together. Biofilms can corrode the hulls of ships, pollute drinking water systems, form plaque on teeth, and stick to medical devices implanted in humans, resulting in infection or rejection.

Research at Syracuse University, NY aims to develop surfaces that will resist biofilm formation and to gain a better understanding of how biofilms are formed and how they interact with the surfaces that they adhere to. Yan-Yeung Luk, Assistant Professor of Chemistry in SU’s College of Arts and Sciences, and Dacheng Ren, Assistant Professor of Biomedical Engineering in the L. C. Smith College of Engineering and Computer Science, created a surface material that could be modified.
chemically to repel both bacterial and mammalian cells. They found that the surface could also be manipulated to confine biofilm growth to surface patterns of desired two-dimensional shapes. This was shown to last four times longer than current technologies. ‘Our surfaces are able to reveal that mammalian cell adhesion requires the existence of an anchor, while bacteria can adhere to almost any sticky surface’, Luk says. The surfaces were created by applying a thin film of gold, about 20 nm or five atoms thick, to a glass surface. The gold was then coated with the chemical molecules that Luk and his team created to prevent protein sticking to the surface. ‘This level of surface control has never before been achieved’, Ren says. ‘We hope that what we have learned in the laboratory will help answer other fundamental questions in surface materials research and lead to the production of new materials for use in medicine and industry.’

This discovery may make it possible to answer critical questions that previously eluded scientists and lead to the development of improved medical implants and to new ways to prevent the formation of biofilms.

For further information contact Professor Yan-Yeung Luk, Syracuse University, USA, email yluk@syr.edu.

Large scale manufacture of hybrid solar cells

Single crystal silicon based photovoltaics are favourable because they offer high conversion efficiencies. However, they are expensive to make, which limits the widespread use of photovoltaics as a renewable energy source. This has led to research on a number of other technologies, including polymer and nanomaterials based solar cells. Polymer solar cells are inexpensive and easy to manufacture, but they have a low photon-to-power conversion efficiency. Nanocrystalline materials show promise for solar materials because of their size tunable optical and electronic properties. However, there are fears concerning the toxicity and the potential level of danger/harm caused by heavy metal containing nanomaterials such as CdSe, PbSe or InAs.

Research at the University of Minnesota has produced a ‘hybrid’ photovoltaic cell combining silicon nanocrystals with polymer solar cells. The photoactive region consists of a blend of silicon nanocrystals dispersed in conducting P3HT polymer, which is layered on to an ITO (indium tin oxide) coated glass substrate. The silicon nanocrystals and conductive polymer P3HT can be processed from solution, thus making the solar cell suitable for inexpensive, large-scale manufacture. The silicon nanocrystals deliver an incident photon-to-current efficiency (IPCE) of 1-15%, improving the performance relative to a P3HT-only cell. The incorporation of silicon nanocrystals also avoids the presence of heavy metal based nanomaterials.

For further information contact Uwe Kortshagen, University of Minnesota, USA, email uk@me.umn.edu.

Biodegradable artificial wood

Researchers at Stanford University have developed a synthetic wood substitute that is both durable and recyclable. The artificial wood is made from biodegradable composites, or biocomposites, which are glue-like resins reinforced with natural fibres that are made from plants and recyclable polymers. The group, led by Sarah Billington, Associate Professor of Civil and Environmental Engineering, tested a number of materials. They found the best material to be natural hemp fibres fused with the biodegradable plastic resin, polyhydroxy-butyrate (PHB). The artificial wood behaves like natural wood; it can be moulded, hammered or drilled, and can be used in furniture, floors and a variety of other building materials. The bioplastic can be produced faster than wood, and hemp can be grown faster than trees. The goal is to replace the use of natural wood with the artificial wood to save trees, reduce greenhouse gas emissions and shrink landfills.

Graduate students Aaron Michel and Molly Morse with samples of biodegradable wood substitute

The hemp–PHB composites decompose more quickly than natural wood does, taking only a few weeks. To promote decomposition, the artificial wood is buried in a landfill to produce an anaerobic environment for the active micro-organisms. The ideal is to have a material that is stable in service but can then be landfilled, degrade quickly, and be reprocessed into a new component that is fit for purpose. As the biocomposites degrade, methane gas is released. This can be captured and burned for energy recovery or re-used by another set of micro-organisms that consume methane and produce PHB as a byproduct. The group is seeking to combine the degradation of the PHB composites and the production of PHB by methane consuming micro-organisms. The ability to capture the methane produced has the added benefit of combating climate change.

Interest in the hemp-PHB biocomposites has moved beyond artificial wood products and there are plans to use the biodegradable plastic to replace the petrochemical plastics used in disposable water bottles.

For further information contact Sarah Billington, Department of Civil and Environmental Engineering, Terman Engineering Centre, Room 236, Stanford University, Stanford, CA 94305–4020, USA, email billington@stanford.edu.

Award for milk homogenising system

German PhD student, Karsten Kohler, has been awarded the Food Engineer of the Year Award, jointly run by IMechE and the Institution of Food Service Technology (IFST). The award is made to professional engineers, graduates and undergraduates who have shown new and innovative methods of food processing, preservation and packaging. The award, presented by the Institution of Mechanical Engineers (IMechE) and the Master Butcher, Brian Wheatley, included a prize of £1000. Kohler received the award for his paper entitled ‘Design of a microstructured system for homogenisation of dairy products with high fat content’, in which he described the development of a cheaper system for homogenising milk and reduced the fat content. The modified homogenisation process retains 90% of the energy used, instead of the typical 40%, which in turn lowers the overall cost. Fat droplets in whole milk gather to form a thick layer of cream. The cream formed is mixed with skimmed milk, which created whole milk, but with smaller
fat droplets. Fat droplets were also prevented from gathering and this further reduced the formation of the layer of cream.

The competition, which has been running for eight years and is sponsored by the PM Group, opens annually in September to professional engineers, graduates and undergraduates studying or training to become a food engineer. Entries are accepted from all areas of food engineering and entrants must send in a summary of the paper they intend to enter; those shortlisted will then be asked to provide a full paper. The papers are judged by professors from various universities and the members of the IMechE Food Engineering Committee. For further information contact IMechE, tel. +44 (0) 207 304 6888, email media@imeche.org.

Aligning organic microwires

Flexible electronic structures with the potential to bend, expand and manipulate electronic devices could find applications as sensors and as electronic devices to be integrated into artificial muscles or biological tissues. In addition to a biomedical impact, flexible electronics are important for energy technology as flexible and accurate sensors for hydrogen.

Attempts to make flexible electronics faster and less expensive to manufacture have faced difficulties when organic microwires must be aligned as circuits. However, collaboration between researchers at Stanford University and Samsung has led to the development of a technique which will allow engineers to accurately position organic microwires on a substrate and build complex circuits with relative ease. Previous work has not been able to align the nanowires effectively. The new technology developed by Zhenan Bao, a Professor of Chemical Engineering, and her group at Stanford University, can be used to maximise the number of microwires in a circuit and so increase the output current. The organic microwire transistors produced operate 2-5 times faster than those made using existing methods.

The technique involves putting microwires in a liquid solution and filtering them through paper to form transistors. Patterned metal is deposited on to a silica substrate to form the electronic terminals of the microwire transistors. To align the microwires with the terminals, Bao and her group created a mask that matches the alignment of the transistors to the top of the terminals, which is then placed on a piece of filter paper. A vacuum is used to pull the microwires, which are contained in a solution, through the holes in the mask. When the mask is removed, the wires are aligned on the filter paper and match the transistors. The filter paper is then put in contact with the electrodes on the substrate and the wires transferred by dipping the whole device into water.

‘Our goal is to make electronic devices that are lighter in weight and can be coated over a large area’, says Bao. ‘This includes displays that are put onto a plastic substrate and can be folded, low cost sensors that are disposable and electronic tags put on merchandise.’ Future work will include increasing the complexity of patterns in the mask in order to create even more complex circuitry, and testing whether the alignment technique will work with other materials.

Further information from Professor Zhenan Bao, Stanford University, email zbao@stanford.edu.

Cancer targeting nanoprobes

Work at Purdue University has developed nanoprobes capable of identifying cancer cells. The probes contain the antibody Herceptin, which is used in the treatment of metastatic breast cancer. Herceptin identifies and attaches to protein markers on the surface of cancer cells, allowing the probes to distinguish between cancerous and non-cancerous cells. It is also hoped that this technology may be used to deliver drugs to cancer cells.

‘When the cancer cell expresses a protein marker that is complementary to Herceptin, then it binds to that marker,’ explains Joseph Irudayaraj, Associate Professor of Agricultural and Biological Engineering. Whereas previous work has used used gold nanorods or magnetic particles, the new nanoprobes use both. The magnetic particles are detected by MRI while the gold nanorods, which are luminescent, can be traced through microscopy. Microscopy is more sensitive and accurate than MRI, but MRI can be used to track probes deeper within the tissue. This combination of techniques will allow cancer cells to be revealed and doctors to pinpoint accurately the location of a tumour for better treatment.

The nanoprobes have been tested in cultured cancer cells and future work includes running tests on mice models to determine the dose and stability of the probes.

Further information from Professor Joseph Irudayaraj, Department of Agricultural and Biological Engineering, Purdue University, West Lafayette, IN 47907, USA, email josephi@purdue.edu.

Heatstroke sensing helmet

A helmet device that warns against heatstroke has been developed by Hothead Technologies. If the body temperature rises above 40°C this becomes life-threatening, and above 42°C there is cell damage to the brain, liver, kidneys and skeletal muscle. In extreme cases heatstroke can lead to death. Since 2005, heatstroke has killed 33 American football players, most of them high school students, according to a study carried out by the National Centre for Catastrophic Sport Injury Research.

Originally aimed at American Football players, the helmet contains a sensor that is interwoven in the helmet cushion. The probe is located at the front of the helmet and presses against the wearer’s forehead within in the area of the temporal artery. Temperature readings are sent to a PDA via a short range wireless link. The PDA monitors the pattern of temperature change and will be viewed by the coach or trainer. An alarm will go off if the wearer’s temperature reaches 39°C and stays there for more than 20 s. The PDA stores each player’s data, including temperature readings, medical history, and emergency contact information in a database.

The sensors and radio transmitters can be fitted into other types of helmet. Hothead is currently developing a headband version, which can be used with all types of headgear. Further information at www.hotheadsports.com.

New nanotech coating for brain implants

Biomedical and materials engineers at the University of Michigan, Ann Arbor, have developed a coating which they claim will immediately increase the efficiency of brain implants. Brain implants are used to treat a number of neurological disorders including paralysis, epilepsy, depression and
Parkinson's disease. They work in two ways: through the stimulation of neurons with electrical impulses, which act to override the brain's own signals, or by redirecting signals sent to non-working parts of the brain. Current implants utilise brain penetrating microelectrodes, which allow for direct communication with individual neurons, with the potential to record extremely precise information about a movement or an intended movement.

Although brain penetrating micro-electrodes offer more precise control of signals than previous methods used (on-scalp and brain surface electrodes), they become less reliable after a few months. This decline in efficiency is due to the immune response triggered by the tissues of the brain, and the tissue damage which sometimes occurs with the implants. The immune response, encapsulation, is triggered by the detection of non-self-antigens present on the implants. This response tells the body to envelope foreign materials.

Mohammad Reza Abidian, a post-doctoral researcher in the Department of Biomedical Engineering, was among the developers of the new coating. ‘You want to be able to use these microelectrodes for at least a couple of years’, Abidian said. ‘Current technology doesn’t allow this in most cases because of how the tissues of the brain respond to the implants. The goal is to increase their efficiency and their lifespans.’

The new coating acts to overcome the rejection encountered by current brain-penetrating microelectrodes to subsequently increase its efficiency and lifespan. The nanotech coating is made of three components: a special electrically conductive nanoscale polymer, PEDOT; a natural, gel-like buffer called alginate hydrogel; and biodegradable nanofibres loaded with a controlled-release anti-inflammatory drug.

The PEDOT enables the electrodes to operate with less electrical resistance than current models, which means they can communicate more clearly with individual neurons. Tissue damage is reduced by the alginate hydrogel present in the coating. Partially derived from algae, the hydrogel gives the electrodes mechanical properties similar to brain tissues therefore causing less tissue damage and reducing the immune response triggered.

The biodegradable, drug-loaded nanofibres work with the alginate hydrogel to release the anti-inflammatory drugs in a controlled, sustained fashion as the nanofibres themselves break down. The anti-inflammatory drugs released reduce the harshness of the encapsulation response and the damage caused to surrounding tissues. A paper on this research, called ‘Multifunctional nanobiomaterials for neural interfaces’, was published in the 24 February issue of Advanced Functional Materials.

For further information contact Dr Mohammad Reza Abidian, Department of Biomedical Engineering, 2218 Dental Bldg, 1011 North University St, University of Michigan, Ann Arbor, MI 48109, USA, email mabidian@umich.edu.

### Spinning nanotubes

Researchers at the University of Cincinnati (UC) have shown that carbon nanotubes (CNTs) which have been spun into strong threads have additional properties that may be of use in both military and consumer applications. Using methods which have already been shown to grow CNTs of considerable length, researchers in the UC College of Engineering NanoWorld Lab were able to produce fibres which were longer and stronger than those from conventional techniques.

David Mast, from UC’s McMicken College of Arts and Sciences, first saw evidence of the potential for stronger threads when he took a 25 μm carbon nanotube thread and created a dipole antenna using double-sided transparent tape and silver paste. He found that this could be used to successfully transmit both AM and FM radio signals almost as well as copper did, but at about one ten-thousandth of the weight. Mast then went on to replace his cell phone antenna with one he had made himself using CNT thread and tape. This also proved to be successful, four to five bars of service being obtained with the nano-antenna, compared with none when he removed it. Although producing the antenna is relatively straightforward, the nanotubes are difficult to manipulate, since they float on air.

The new properties are due to the quality of material used. Vesselin Shanov and mark Schulz of the NanoWorld Lab used multi-wall CNTs.

The ability of the CNTs to work well as an antenna is attributed to the skin effect, by which electrons are transferred on the surface (or skin) of the carbon structures rather than through the bulk. Future directions include improvements to the CNT thread, such as making yarn out of several threads, and to find industries that will commercialise CNT thread.

Further information from Dr Vesselin Shanov, Department of Chemical and Materials Engineering, University of Cincinnati, OH 45221-0012, USA, email vesselin.shanov@uc.edu or Dr Mark J. Schulz, Mechanical Engineering, email mark.schulz@uc.edu.

### Biodegradable medical implant collaboration

A five year Engineering Research Centre (ERC) grant of $18.5m has been awarded to North Carolina Agricultural and Technical State University (NCAT), by the US National Science Foundation (NSF). In collaboration with the University of Pittsburgh and the University of Cincinnati, NCAT will lead the research on this project to create medical devices that can adapt to a patient’s anatomy and dissolve when no longer needed.

The ERC project will aim to create orthopaedic, craniofacial and cardiovascular devices for adults and children, which are biodegradable and self-adapting. The devices are intended to reduce the need for follow-up surgeries sparing patients from the potential complications associated with multiple surgeries. The self-adapting properties will enable the devices, made from magnesium alloys and other biodegradable metals, to adapt to physical changes such as the growth of the patient. The devices should biodegrade once they are no longer required and produce no clinical side effects. Since there is no need to remove the device, this again reduces follow-up surgeries and potential complications of major orthopaedic, craniofacial, and cardiovascular procedures.

The ERC project will also focus on the development of miniaturised sensing systems to monitor and control the safety and effectiveness of biodegradable metals inside the body. ‘The treatment of diseased and traumatised tissues is evolving as medical technologies increasingly harness the body’s regenerative powers’, says Pittsburgh Professor William Wagner, one of the ERC collaboration.
Deputy Directors. ‘This centre will extend this approach by combining the mechanical attributes of metals with biologically active agents that together will further encourage the natural healing process.’

Further information from Project Director Professor Jagannathan Sankar, Department of Mechanical Engineering, College of Engineering, NCAT, USA, email sankar@ncat.edu.

**Nanotube enhanced commutators**

Researchers at Rice University, USA and collaborators at the University of Oulu, Finland have demonstrated the ability of carbon nanotubes (CNTs) to improve the performance of electrical commutators, which are common components of electric motors and generators. The light weight, potential durability and good thermal and electrical conductivity of CNTs make them candidate materials for brush contacts.

Brush contacts form an integral part of commutators, the spinning electrical switches used in many battery powered electrical devices, such as cordless drills. Brushes act as conducting pads, passing current from the spinning disc to other parts of the device. They are held on the spinning disc by spring loaded arms.

Current brush contacts use a carbon–copper composite, which was replaced in the study with small blocks containing many CNTs –30 nm in diameter. The nanotube contact pads had 10% of the resistance of the carbon–copper composite brushes. ‘The findings show that nanotubes have a great deal of practical relevance as brush contacts’, said lead researcher Pulickel Ajayan. ‘The technology is widely used in industry, in both consumer gadgets and larger electrical machinery, so this could be a very interesting, near-term application for nanotubes.’

In previous work Ajayan showed that when compressed, these small blocks of nanotubes regained their shape quickly. It is believed that this recovery keeps a greater proportion of their surface area in contact with the spinning disc, resulting in a 90% reduction in energy loss. This elasticity is not found in existing composites.

This research appeared online in March in the journal *Advanced Materials*. Support for the research is provided by the Academy of Finland, the University of Oulu’s Micro and Nanotechnology Center, the Air Force Office of Scientific Research and the Semiconductor Research Corporation. Further information from Professor Pulickel Ajayan, Department of Mechanical Engineering & Materials Science, Rice University, 6100 Main Street, Houston, TX 77005, USA, email ajayan@rice.edu.

**Light bending metamaterial**

Researchers at Rice University have created a metamaterial that collects light from all directions and emits it in a single direction. Graduate student, Nikolay Mirin, had been trying to make a thin gold film with nano-sized holes. The discs knocked out created very small, cup shaped particles called nanocups, which previous work has shown to have interesting properties. Mirin is thought to be the first to isolate nanocups and preserve their matching orientation so that the properties of these oriented nanostructures can be examined.

To isolate the nanocups, Mirin distributed polystyrene or latex nanoparticles randomly on a glass substrate. Then thin layers of gold were deposited on to the substrate from various angles. Cups formed around the particles could then be locked into an elastomer and lifted off of the substrate. The material produced could capture light from any direction and was able to focus it into a single direction. As scattered light is redirected, light bouncing off the metamaterial can be focused away from the eye of an observer, thus giving the material ‘invisible’ properties. ‘Ideally, one should see exactly what is behind an object’, said Mirin. ‘The material should not only retransmit the colour and brightness of what is behind, as squid or chameleons do, but also bend the light around, preserving the original phase information of the signal.’

The metamaterial may also be used to increase the efficiency of solar cells, where at present ~80% of the light passes right through the device and where there is great interest in making cells as thin as possible for many reasons. The nanocups could be used to focus light into a beam on the active region of the solar cell. This will allow solar panels to be made smaller and made less expensive for commercial use.

The next intended step is to pursue use of the nanocup metamaterial to transmit optical signals between computers.

This research appears in the February issue of the journal *Nano Letters*. Further information from Professor Naomi Halas, Department of Electrical and Computer Engineering, Rice University, Houston, TX 77005-1892, USA, emmail halas@ece.rice.edu.

**High resolution images of bone formation**

Researchers at Eindhoven University of Technology have obtained what are believed to be the first high resolution images of the earliest stages of bone formation. Using the cryoTitan high resolution electron microscope, they produced three-dimensional images of the nanoparticles present in the initial stages of bone formation. These results provide an improved understanding of bone, tooth and shell formation.

At the beginning of the formation of crystalline biominal, Nico Sommerdijk and his colleagues observed small clusters with a cross-section of 0.7 nm in a solution of calcium carbonate, the basic material of which shells are made. The clusters were then seen to nucleate into larger, unstructured nanoparticles with an average diameter of ~30 nm. By applying an organic surface to the clusters, Sommerdijk was able to encourage the growth of the nanoparticles into larger particles. The organic surface also controlled the direction in which the nanoparticles could grow into a biomaterial.

Sommerdijk and his team hope to further develop this research for use in nanotechnology to control the growth of nanoparticles in the same way as seems to be the case in nature. Findings from this study were reported in the 13 March issue of Science.

For further information contact Dr Nico Sommerdijk, Eindhoven University of Technology, Chemical Engineering and Chemistry, Soft Matter CryoTEM research unit, Materials and Interface Chemistry, PO Box 513, Helix STO 2 445600 MB Eindhoven, The Netherlands, email n.sommerdijk@tue.nl.

**Patch to extend aircraft life**

The independent Basque technology corporation Tecnalia will lead the IAPETUS project, within the European Union 7th Framework Programme, to develop a composite patch for the repair of aluminium and new generation compound materials aircraft. The
new patch will extend the life of the aircraft, increase reliability and reduce the costs of repairs. Approximately 30% of the world’s fleet of commercial aircraft is more than 15 years old. Corrosion and fatigue age the craft structure further. The composite patch will consist of a composite of carbon nanotubes (CNTs) in a polymer matrix. CNTs are used in the matrix of the composite material as well as in the adhesive used to apply it, and their good electrical conductivity should compensate for the conductivity loss from replacing the damaged component with the patch.

The programme consortium is made up of a variety of centres of a multidisciplinary nature: a total of 10 companies from France, Greece, Poland, the UK, Switzerland and Spain (Aeronautic Structures and Component Manufacturers, DAHER Aerospace, Hellenic Aerospace Industry and PZL-Swidnik SA, Repair Technologies’ equipment, GMI Aero, Resins for Composite Materials and Hurstman Advanced Materials); a number of universities (Patras, Ioannina and Sheffield) and technological centres (INASCO and INASMET-Tecnalia).

Tecnalia’s mission will be to develop the hardening materials and techniques for the maintenance of aircraft and a sensor for fault detection, which will act as a preventive measure. For further information visit www.tecnalia.info.

**Platinum nanowires for fuel cells**

Nanowire enhanced fuel cells, produced by James Li and graduate student Jianglan Shui at the University of Rochester, NY, could expand the commercial applications for fuel cells. It is believed these enhanced cells have potential to power many types of vehicle. ‘Our ultimate purpose is to make free standing fuel cell catalysts from these nanowires’, says Li. Long platinum nanowires, roughly 10 nm in diameter, serve as the electrode in the fuel cell. These nanowires were created by electrospinning, which is able to produce long, ultra-thin fibres.

Platinum has primarily been used to make fuel cell catalysts, which facilitate the reaction of hydrogen and oxygen within the fuel cell. Platinum has been the material of choice as it is more energy efficient than cheaper metals and it is able to withstand the hostile environment created inside the fuel cell by the splitting of hydrogen into electrons and acidic hydrogen ions. ‘People have been working on developing fuel cells for decades. But the technology is still not being commercialised,’ says Li. ‘Platinum is expensive, and the standard approach for using it in fuel cells is far from ideal. These nanowires are a step toward better solutions.’

**Sunlight to liquid fuels**

One goal of artificial photosynthetic is to produce liquid fuel from carbon dioxide and water. Researchers in the US Department of Energy’s Lawrence Berkeley National Laboratory have discovered that cobalt oxide nanocrystals can be used to split water molecules, similar to the photosynthetic reaction producing oxygen, electrons and hydrogen ions. The electrons produced can then be used to reduce carbon dioxide to a fuel.

Heinz Frei conducted this work with his postdoctoral fellow Feng Jiao.

Frei explains why nano-sized crystals of cobalt oxide are suited to this task: ‘Effective photo-oxidation requires a catalyst that is both efficient in its use of solar photons and fast enough to keep up with solar flux in order to avoid wasting those photons. Clusters of cobalt oxide nanocrystals are sufficiently efficient and fast, and are also robust (lasting a long time) and abundant. They perfectly fit the bill.’

**Platinum micrograph of platinum nanowires without beads**

The standard approach to using platinum in fuel cells involves nanoparticles. The idea behind this is that the nanoparticles have a greater exposed surface area and as a result this should give greater rates of catalysis and consequently, greater energy efficiency. But nanoparticles have the tendency to merge, which decreases the surface area and therefore the rate of catalysis within the fuel cell. The nanoparticles also need to be held in place by a carbon support structure. This is not ideal as the platinum particles did not attach well to the structures and would become dislodged and lost. With Li’s approach, platinum is arranged into wires so the particles are fixed in place and require no additional support.

Li hopes to further optimise laboratory conditions to produce longer, more uniformly thin nanowires. Non-optimal conditions in the production of the nanowires lead to the formation of platinum beads along the nanowires. As a result, the affected surface area can no longer be used in the catalytic process and the rate of catalysis is reduced.

Studying five variables that affect bead formation and eventually allowed the production of nanowires that are almost bead free.

Further information from James C.M. Li, A. A. Hopeman Professor of Mechanical Engineering and of Materials Science, University of Rochester, Hopeman 221, Rochester, NY 14627, USA, email li@me.rochester.edu.
overpotential and mild pH and temperature conditions, we believe we have a promising catalytic component for developing a viable integrated solar fuel conversion system, says Frei. The next step will be to integrate the water oxidation half-reaction with the carbon dioxide reduction step in an artificial leaf type system.

The findings of this study have been published in Angewandte Chemie, in a paper entitled ‘Nanostructured cobalt oxide clusters in mesoporous silica as efficient oxygen-evolving catalysts’. This research was performed through the Helios Solar Energy Research Center (Helios SERC), a scientific programme at Berkeley Lab under the direction of Paul Alivisatos aimed at developing fuels from sunlight.

For further information contact Heinz Frei, Lawrence Berkeley National Laboratory, Physical Biosciences Division, One Cyclotron Road, Berkeley, California 94720, USA, email hmfrei@lbl.gov.

Forthcoming conferences

Superplasticity in Advanced Materials 2009
29 June–2 July 2009, Seattle, WA, USA
The 10th International Conference on Superplasticity in Advanced Materials will bring together researchers from academia and industry who are engaged in the study of superplasticity and superplastic forming (SPF) of materials. A poster session will run alongside talks. Speaker sessions will cover topics in:

- industrial applications and innovations
- superplasticity in metal alloys
- numerical simulations and modelling.

As of March 2009, confirmed speakers include: Terry Langdon, Richard Todd, K.F. Zhang, Ruslan Valiev, Norman Ridley, Keijiro Hiraga, Amiya Mukherjee and Gerard Bernhart. The conference proceedings will be published in book form and in the Key Engineering Materials Journal. For further information visit http://depts.washington.edu/uwconf/.

Alloys for Critical Applications
7–8 July 2009, Sheffield, UK
Organised by the Sheffield Metallurgical and Engineering Association (SMEA) and Co-sponsored by The Iron and Steel Society of the Institute of Materials, Minerals and Mining, this conference will explore recent developments in the manufacture, evaluation and application of alloy steel, nickel based superalloy and light metal components for critical engineering applications. Five technical sessions will focus on nuclear energy, aerospace, energy supply chain and transport applications, and then consider some advanced technologies. On the evening of Tuesday 7 July, the SMEA Celebrity Lecture ‘Out of the black into the blue’ will be given by Dr Graham Honeyman, Chief Executive, Sheffield Forgemasters International.

For further information visit www.iom3.org/events/alloys-critical-applications-smea-conference-2009 or contact the conference organiser, Dr Ken Ridal, email kenridal@stonedelf.fsnet.co.uk.

Organic Microelectronics & Optoelectronics Workshop V
6–9 July, 2009, San Francisco, CA, USA
The workshop will bring together a broad spectrum of chemists, materials scientists, physicists, and engineers from both industry and academia in a stimulating forum to share information and ideas in the emerging fields of organic microelectronics and optoelectronics. The goal is to build an interdisciplinary community working on applications such as rfid, displays, sensors, photovoltaics and optical devices while addressing some of the common scientific and manufacturing challenges to help these technologies advance in a more rapid, effective, and economical manner.

The technical programme will focus on the areas of synthesis, theory, novel processing/patterning/fabrication and device physics through a series of presentations by renowned invited speakers and poster sessions. For further information, please visit www.mrs.org.

Engineering Solutions for Sustainability: Materials and Resources
22–24 July 2009, Lausanne, Switzerland
This three-day workshop will focus on materials and resources integral to meeting basic societal needs in critical areas such as:

- energy
- transportation
- housing
- health.

Presentations will focus on the engineering answers for cost effective, sustainable pathways, the strategies for effective use of engineering solutions, and the role of the global engineering community. The event will be of benefit to those working within the engineering sector globally and to those involved in infrastructure and general development projects across developing and developed nations.

The committee also welcomes representatives of non-governmental and governmental organisations as well as mineral resource professionals and those involved in education and research. Workshops will allow attendees to share their perspective on the major engineering challenges that face our world today and identify, discuss and prioritise engineering solution needs in each area.

For further information visit www.spe.org/events or contact the conference organiser, Michele Gottwald, email gottwald@aimehq.org.

Integrating Computational Materials Science and Engineering
2–7 August 2009, Andover, NH, USA
The aim of this Gordon Conference is to explore recent progress in use of computational materials models to unify the science and engineering of metallic materials. Integrated computational materials engineering (ICME), also known as through process modelling, is a new and potentially transformational discipline within the