Technology Scan

ASIA-PACIFIC

AUSTRALIA

Rapid prototype process

One key to making inexpensive metal parts is being able to quickly manufacture intricate shapes. Rapid prototyping processes are routinely used for plastics and some metals, but aluminum has proved elusive.

Aluminum is tricky because it conducts heat very quickly and is also highly reflective. This makes it difficult to turn powdered aluminum to liquid with lasers.

Researchers from the University of Queensland in Australia have come up with a rapid manufacturing process for aluminum that infiltrates an aluminum alloy powder with a liquid aluminum alloy. The process paves the way for fast, inexpensive manufacturing of aluminum prototypes and parts. Objects made using the process have the same properties as ordinary cast aluminum, but can contain more complex shapes and smaller features, according to the researchers.

The process is similar to the rapid prototyping method used for steel, which infiltrates steel power with bronze. The process also adapts rapid prototyping methods for manufacturing parts from computer-generated designs.

The trick to adapting these methods to aluminum is first forming an object using a combination of aluminum powder and resin. At the start of the infiltration process, the heat burns off the resin but hardens the powder in time to hold the object's shape. The system could be ready for commercial use in one or two years, according to the researchers. The work appeared in the August 29 issue of *Science*.

http://www.technologyreview.com

CHINA

Nanometre-scale photo-catalyzing agent

Prof. Zou Zhigang, Director of Environmental Materials and Renewable Energy Research Centre, Nanjing University has, in collaboration with Japan Institute of Integrated Industrial Technologies, applied the knowledge gained from studying superconducting oxide materials in photo-catalyzing, and worked out for the first time, the photo-catalyzing agent with visible response for complete water decomposition.

While working on new environmental materials and energy at Nanjing University, Prof. Zou and others for the first time achieved water decomposition based hydrogen making, through the photo-catalyzing process. In his demonstration, Prof. Zou rested two glass panels coated in deep colour under a desk lamp of 60 w, turned on the lamp and connected the electric wire at the end of the glass panel to a simple fan.

It took less than one second for the fan to get rotated. When the lamp was turned off, the fan ceased to move, thanks to the nanometre-scale photo-catalyzing material coated on the glass panel. Through such a medium, it is possible to convert solar energy not only into a chemical form of energy, namely hydrogen, but also into electric energy, to substitute for hydraulic and thermal power. In the meanwhile, the process is able to decompose toxic matter and purify the environment. The inventor has filed patent applications in both China and Japan. The technology is expected to be applied extensively in many fields by 2030, and has many likely applications.

http://www.most.gov.cn

Non-conductive film interconnection

The Electronics Research & Service Organization (ERSO) of Industrial Technology Research Institute (ITRI) has successfully developed a non-conductive film interconnection process for Chip-on-Flex (COF) technology used in LCD (liquid crystal display) modules. Capable of reducing the size of an interconnecting pitch down to 30 µm, the process is expected to achieve high pin-count, integrate more functions into LCD driver ICs, cut material cost, and decrease overall product size as well. Conventionally, Chip on Glass (COG) and Tape Automated Bonding (TAB) have been two major thrusts of packaging methods adopted by small to large-sized LCD products alike. With the principal advantages of increased I/O density, increased number of active/passive drivers, superior electrical and thermal performance and improved reliability, Chip-on-Flex (COF) packaging technology, is now gaining popularity among high-end LCD driver ICs.

While the IC industry has been aggressively pursuing nano-scale manufacturing and packaging technologies, a much higher pin-count resulting from a reduced interconnecting pitch size is becoming more and more significant to ever decreasing die sizes. With the interconnecting pitch down to 30 µm, the pin-count in a 10.9 mm x 2.9 mm test chip, for example, can reach 623.

In addition, fabricated on a flex substrate so as to reduce the total volume of LCD driver IC package, ERSO COF with non-conductive adhesive is ideal for portable electronic devices, demanding light weight, thinness, full colour and high resolution. Today's thriving market for personal products such as mobile phones, palm-size digital devices, and digital cameras provides great opportunities for commercial applications using this new innovation.

ERSO plans to transfer this promising technology to local companies for mass production. With the first technology for non-conductive films interconnection process in Taiwan, it is anticipated that LCD panel and module companies can significantly improve the quality and competitiveness of their products.

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INDIA

Spin-off technologies

The multi-disciplinary research carried out by the Bhabha Atomic Research Centre (BARC) has helped in generat-

ing a number of spin-off technologies not only for the benefit of the industry but more so for society. These range from scientific devices to healthcare items. Of these, the BARC has transferred nine technologies to industry.

The items of medical use include a hydrogel for burns and wound dressings; daily-use gadgets such as vibro-thermal disinfectors for disinfestation of food grains and an on-line domestic water purifier, based on the ultra-filtration method. Some technologies like electronic beam welding, manipulators and other devices are under development.

The technical services offered by the research centres of the Department of Atomic Energy to industry relate to non-destructive testing, stress measurement, acoustic topography, material characterization, etc. An on-line diagnostic package was also developed for detecting faults in the suspension and wheels of railway coaches, on the basis of track vibration analysis. Analytical services for determining the radio activity content in water and export/import samples were provided to different pharmaceutical and beverage industries as well as export/import houses.

Another spin-off technology developed is a delay mechanism assembly automation system for assembling of explosive parts and supplied to the Ammunition Factory at Kirkee, Pune.

http://www.pib.nic.in

ISRAEL

Self-assembling nano-transistor

A functional electronic nano-device has been manufactured, using biological self-assembly for the first time. Israeli scientists harnessed the construction capabilities of DNA and the electronic properties of carbon nanotubes to create the self-assembling nano-transistor. The work has been greeted as "outstanding" and "spectacular" by nanotechnology experts.

The push to shrink electronic circuits to ever smaller dimensions is relentless. Carbon nanotubes, which have remarkable electronic properties and are only about one nanometre in diameter, have been touted as a highly promising material to help drive miniaturization. But manufacturing nanoscale transistors has proved both time-consuming and labour-intensive.

The team, at the Technion-Israel Institute of Technology, overcame these problems with a two-step process. First they used proteins to allow carbon nanotubes to bind to specific sites on strands of DNA. They then turned the remainder of the DNA molecule into a conducting wire.

"DNA is very good at building things in molecular biology, but unfortunately, it does not conduct electricity. We had to get a metal conductor on the DNA," explains physicist Erez Braun, who led the research.

"This is spectacular work," says Cees Dekker, a nanoscience expert at Delft University in the Netherlands. "It demonstrates that it's possible to use biology to build an inorganic device that works."

"But while it is a first step towards molecular computing, based on this type of DNA configuration, we are still many years away from large-scale self-assembly electronic devices, such as computers," Dekker cautions.

Braun's team began their manufacturing process by coating a central part of a long DNA molecule with proteins from an *E. coli* bacterium. Next, graphite nanotubes coated with antibodies were added, which bound themselves onto the protein.

After this, a solution of silver ions was added. The ions chemically attach to the phosphate backbone of the DNA, but only where no protein has attached. Aldehyde then reduces the ions to silver metal, forming the foundation of a conducting wire.

To complete the device, gold was added. This nucleates on the silver and creates a fully conducting wire. The end result is a carbon nanotube device, connected at both ends by a gold and silver wire.

The device operates as a transistor, when a voltage applied across the substrate is varied. This causes the nanotubes to either bridge the gap between the wires - completing the circuit - or not.

Out of 45 nanoscale devices created in three batches, almost a third emerged as self-assembled transistors. They work at room temperature and the only restriction for future devices is that the components must be compatible with the biological reactions and the metal-plating process.

The team have already connected two of the devices together, using the biological technique. "The same process could allow us to create elaborate self-assembling DNA sculptures and circuitry," says Braun.

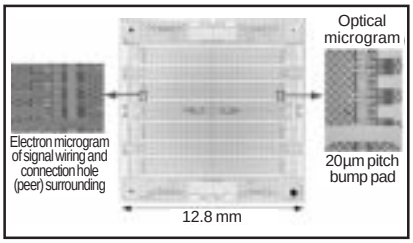
http://www.newscientist.com

JAPAN

LSI chip-connecting interposer

The High Density SI Group of Nanoelectronics Research Institute, National Institute of Advanced Industrial Science and Technology is an independent administrative institution. It has succeeded in the development of high density fine wiring interposer for connecting LSI chips to implement ultra-high-speed and ultra-high density packing. This it has achieved in collaboration with a technological research association, Association of Super-Advanced Electronics Technology (ASET).

High density connection interposer



The performance of LSI chips is advancing by leaps and bounds year after year, as demonstrated by the clock frequency of CPU chips surpassing 3GHz. However, the clock frequency for signal transmission over external paths such as those from CPU chips to memory is as low as 500MHz. Owing to the difference in transmission rate by a factor (which might range from just a few to dozens),

the processing rate of the entire system fails to cope with the increasing volume of information. For this reason, the clock frequency for the transmission over the linkage between LSI chips is required to be as fast as that for LSI chips.

One of the technologies to meet this requirement is high-density system packing technology, also termed System-In Package (SiP), where multiple LSI chips are combined to operate like a single LSI chip. In the present R&D work, a high density fine wiring interposer for 3D connection of solid build-up of LSI chips has been developed successfully for the first time in the world.

The high density fine wiring interposer is characterized by a high performance signal wiring structure (strip line construction), which ensures 10 gbps transmission rate, suited for optoelectronic high-speed transmission modules, and by 50µ characteristic impedance, which allows matching with existing peripheral devices. The structure has been achieved by using photosensitive polyimide (relative permittivity 3), a low permittivity organic insulator material, as an insulating layer between metal wirings. With this insulator, it has become possible to reduce the minimum wire width from 50 µm (1 µm = 10^{-6} m) or so in the conventional printed circuit board technology to as fine as 7.5 µm.

The connection with LSI chips is designed with fine bumps of 20 µm pitch fitted to the LSI chip direct connection (flip chip linkage) forming process. In the fabrication of high-density fine wiring interposer, the use of high resolution photosensitive polyimide insulation layer has made it possible to realize wiring linkage holes (peer holes) through the optical transfer (lithography) process alone, to simplify the process extensively. This will reduce the cost of the manufacturing process in commercialization.

This study has been carried out as a part of the Next Generation Semiconductor Devices & Processes Basic Technology Programme "Ultra-High Density Electronic System Integration (SI) Technology", sponsored by the New Energy and Industrial Technology Development Organization (NEDO).

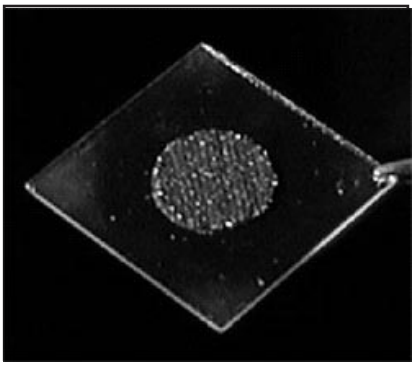
In relation to the results of this study, three patent applications have been filed.

http://www.aist.go.jp

Nano-technology materials for DMFC

The Special Division of Green Life Technology, the National Institute of Industrial Science and Technology (AIST) succeeded in manufacturing a direct methanol fuel cell (DMFC). This was based on a porous glass electrolyte developed by AIST in collaboration with New Glass Forum, New Energy and Industrial Technology Development Organization (NEDO) and Himeji Institute of Technology (HIT). The DMFC led to power generation. This fuel of high methanol concentration showed a higher output than conventional fuel cells, which use perfluorosulphonate membrane, such as "Nafion".

A porous glass electrolyte membrane-electrode assembly



In a DMFC, which is a promising power source for next-generation mobile instruments, the use of methanol fuel with high concentration inevitably causes extensive degradation of performance, because of marked methanol crossover in the conventional electrolyte membrane of perfluorosulphonate. This requires that methanol be diluted with water in the ratio of one to ten, forcing a decrease in energy density.

The new technology, based on nanopore glass, is expected to raise the output density of the DMFC system and to extend the operational time span of mobile instruments.

http://www.aist.go.jp

MALAYSIA

Advanced microchip

Malaysia has acquired the property rights to the most advanced microchip - the Malaysian Microchip (MMchip). The Malaysian Government and First Hill Electronics Co (M) Sdn Bhd. signed an agreement which gives Malaysia the rights to design, produce and market the microchip.

The MMchip measures 0.25 sq mm - approximately the size of a decimal point - and can be embedded in paper. It is useful for a variety of purposes, such as replacement for barcode tags on retail goods, for differentiating between genuine and counterfeit currency notes, and for use in passports.

The MMchip is a multiband RFID (next-generation radio frequency identification) chip, which means that it could also be usable in the U.S. and Europe, which have adopted a different RFID frequency standard from that in Japan.

http://www.pwc.com

EUROPE

SPAIN

Interference boosts biochip

Researchers from the Spanish Superior Counsel of Scientific Research and the Polytechnic University of Valencia in Spain have built a chip that senses interactions among molecules via light-wave interference.

The device is twice as sensitive as existing molecular sensors, and could eventually be used for medical diagnostics and research, and for quick detection of water pollutants and chemical and biological warfare agents in the field, according to the researchers.

The researchers' device is a type of interferometre, which splits a light beam in two and then joins them again. If a split beam interacts with a substance, it will be out of phase when joined with its other half, making the beams interfere with each other to some degree when they combine.

The device also contains molecules that bind to certain target molecules, and when a receptor molecule binds to a target molecule it changes the degree of light interference. These changes can be sensed within seconds or minutes to confirm the presence of a target molecule.

The researchers made the device using standard silicon manufacturing techniques; it could eventually be integrated along with other electronics into a single computer chip.

The sensor could be used practically in five to ten years, according to the researchers.

http://www.technologyreview.com

UK

Fingerprint technology

Scientists say nanotechnology could, in the future, help police catch criminals by providing clearer and more detailed fingerprints.

Current powders used by detectives to pick up prints work because the oil from fingers has a natural tackiness. But researchers at the University of Sunderland are developing a nanoparticle dust which actively seeks out any oil, however small the amount that is left. While current prints are sometimes not clear enough to lead to a suspect, the new dust should provide a much more detailed picture, according to New Scientist magazine.

The nanoparticles are tiny glass spheres between 200 and 600 nanometres in diameter, too small to be seen individually by the human eye. As well as being speckled with a fluorescent dye, they are coated with hydrophobic molecules which are repelled by water and attracted to oil, fixing tightly to the fingerprint.

Lead researcher Fred Rowell said the nanoparticles should pick out even the faintest of prints because they are able to stick to tiny traces of oil. He also said they should be much sharper, with finer details which could be crucial to identifying a print.

The research, which is still in its early stages, has been presented to police officials at the Nanotechnology in Crime Prevention and Detection conference.

http://www.ananova.com

NORTH AMERICA

USA

Ultra-high-temperature ceramics

Researchers at the Department of Energy's Sandia National Laboratories have developed a new lightweight material to withstand ultra-high temperatures on hypersonic vehicles, such as the space shuttle. The ultra-high-temperature ceramics (UHTCs), created in Sandia's Advanced Materials Laboratory, can withstand up to 2000°C (about 3,800°F).

Ron Loehman, a senior scientist in Sandia's Ceramic Materials, said that results from the first seven months of the project have exceeded his expectations. "We plan to have demonstrated successful performance at the lab scale in another year, with scale-up the next year," Loehman said.

Thermal insulation materials for sharp leading edges on hypersonic vehicles must be stable at very high temperatures (near 2000°C). The materials must resist evaporation, erosion, and oxidation, and should exhibit low thermal diffusivity to limit heat transfer to support structures.

UHTCs are composed of zirconium diboride (ZrB_2) and hafnium diboride (HfB_2), and composites of those ceramics with silicon carbide (SiC). These ceramics are extremely hard and have high melting temperatures (3245°C for ZrB_2 and 3380°C for HfB_2). When combined, the material forms protective, oxidation-resistant coatings, and has low vapour pressures at potential use temperatures. "However, in their present state of development, UHTCs have exhibited poor strength and thermal shock behaviour, a deficiency that has been attributed to inability to make them as fully dense ceramics with good microstructures," Loehman said.

Loehman said the initial evaluation of UHTC specimens, provided by the NASA Thermal Protection Branch about a year ago, suggests that the poor properties were due to agglomerates, inhomogeneities, and grain boundary impurities, all of which could be traced to errors in ceramic processing.

During the first seven months, the researchers made UHTCs in both the ZrB_2 and HfB_2 systems that are 100 per cent dense or nearly so. They have favorable microstructures, as indicated by preliminary electron microscopic examination. In addition, the researchers have hot pressed UHTCs with a much wider range of SiC contents than ever before. Availability of a range of compositions and microstructures will give system engineers added flexibility in optimizing their designs.

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Photonic crystals boost semiconductor lasers

Physicists have made a new type of laser by combining a quantum cascade laser with a photonic crystal. Raffaele Colombelli and colleagues of Bell Labs in the US say that their novel proof-of-concept device could find uses in sensing applications and fundamental research in optics. Conventional semiconductor lasers emit photons when electrons in the conduction band and holes in the electron band recombine. The wavelength or energy of the photon is determined by the energy difference between the conduction and valance bands - which is a fundamental property of the semiconductor.

Quantum cascade lasers, on the other hand, emit light when electrons fall from a higher to a lower energy level in a quantum well. Since the quantum well can contain a whole series of levels, the same electron can emit a large number of photons as it cascades down through the levels. Moreover, the wavelength depends on the width of the quantum well,

which means that photons of more than one wavelength can be emitted by the same device. However, quantum cascade lasers can only emit light in certain directions and cannot emit vertically from the semiconductor surface.

Using dry etching and lithography, Colombelli (now at the University of Paris-Sud) and colleagues have now embedded a tiny photonic crystal - a material that only transmits certain wavelengths of light - in the active region of a quantum cascade laser. The photonic crystal acts as a microcavity that provides feedback for laser action when an electric current is applied. Moreover, the cavity diffracts light vertically from the semiconductor surface. This enables the new device to emit light vertically.

The researchers say that such devices could be used to make large arrays, where each laser emits at a different wavelength, for chemical sensing and optoelectronics applications. They now hope to improve the performance of the new devices so that they will work as well as standard quantum cascade lasers.

http://www.nanotechweb.org

Developments with nanowire film

Researchers at Harvard University have demonstrated that they can apply a film of silicon nanowires to glass and plastic. The development could pave the way for futuristic consumer electronics such as disposable computers and optical displays that can be worn in clothes or contact lenses.

Although a single nanowire is one thousand times smaller than the width of a human hair, it can carry information up to 100 times faster than similar components used in current consumer electronic products, claim the researchers. Scientist have already demonstrated that these tiny wires have the ability to serve as components of highly efficient computer chips and can emit light for multicolour optical displays. But they have had difficulty until now in applying these nanowires to everyday consumer products, says Charles M. Leiber, PhD, head of the research project and a professor of chemistry at Harvard. “As with conventional high-quality semi-conducting materials, the growth of high-quality nanowires required relatively high temperatures,” explains Leiber. “This temperature requirement has, up until now,- limited the quality of electronics on plastics, which melt at such growth temperatures.”

By using a ‘bottom-up’ approach, which involves assembly of pre-formed nanoscale building blocks into functional devices, a film of nanowires can be applied to glass or plastics, long after growth, at room temperature. Using a liquid solution of the silicon nanowires, the researchers have demonstrated that they can deposit the silicon onto glass or plastic surfaces - similar to applying the ink of a laser printer to a piece of paper - to make functional nanowire devices. They also showed that nanowires applied to plastic can be bent or deformed into various shapes without affecting performance.

http://www.electroline.com.au

Towards the terahertz transistor

Researchers at the University of Illinois at Urbana-Champaign have broken their own record for the world’s fastest transistor. Their latest device, with a frequency of 509 GHz, is 57 GHz faster than their previous record holder.

"The steady rise in the speed of bipolar transistors has relied largely on the vertical scaling of the epitaxial layer structure to reduce the carrier transit time," said Milton Feng, the Holonyak Professor of Electrical and Computer Engineering at Illinois, whose team has been working on high-speed compound semiconductor transistors since 1995. "However, this comes at the cost of increasing the base-collector capacitance. To compensate for this unwanted effect, we have employed lateral scaling of both the emitter and the collector," he added.

Feng and graduate students Walid Hafez and Jie-Wei Lai fabricated the high-speed devices in the University’s Micro and Nanotechnology Laboratory. Unlike traditional transistors, which are built from silicon and germanium, the Illinois transistors are made from indium phosphide and indium gallium arsenide.

In January, Feng’s group announced a transistor with a 150 nm collector and a top frequency of 382 GHz. In May, the group reported a 452 GHz device with a 25 nm base and a 100 nm collector. Further scaling reduced the collector size to 75 nm, resulting in a 509 GHz device, announced last month.

http://www.e4engineering.com

IBM claims nanotech breakthrough

Researchers at IBM Corp. claim they have made an important breakthrough in the race to design circuitry at the molecular level: a system that works with existing methods of electronics manufacturing. In a paper read at an industry conference in Washington, D.C., IBM researchers Chuck Black and Kathyrn Guarini said they used a naturally occurring pattern of molecules as a stencil to etch flash memory circuitry into silicon.

Other researchers are experimenting with using self-assembling or naturally forming patterns of molecules to build very tiny circuitry. This is necessary if the high-tech industry is to continue packing more transistors into smaller spaces - the process that continually makes computing faster and less expensive.

But the IBM scientists believe they are the first to use the molecular patterns not as circuits that have to be connected to larger wires but as stencils that light can be shone through to create circuitry in silicon. That would make it more likely to work with existing processes, potentially saving money in manufacturing.

“We don’t just give a nice picture of some sort of material. That’s often where nanotech presentations will end,” Black said. “We take that pattern that nature gives us and have done something with it. We understand it and we know how to build things with it.” The molecules involved are a combination of two polymers - one that makes up Styrofoam and another in Plexiglas. IBM predicts prototype devices using the technique could emerge in three to five years.

http://www.miami.com