Technology Scan

ASIA-PACIFIC

AUSTRALIA

Environmentally friendly die castings

Conventional die castings can be made stronger using new, more environmentally friendly technologies developed by CSIRO. The two new technologies – a dynamic gating system and the 'ATM runner system' – produce high-integrity castings with fine-grained microstructure and low porosity by improving the feed of molten metal into the casting. Both systems are suitable for use with aluminium and magnesium alloys.

"This is accomplished by influencing the flow behaviour of the molten metal, the fill pattern of the die, and subsequent solidification," says the leader of CSIRO's research team of metallurgists and casting engineers, Dr Rob O'Donnell. "Our researchers realised that by changing the way in which molten metal is delivered to the die we could take advantage of the high pressure inherent in the process to make castings with finer microstructure and lower porosity," Dr O'Donnell says.

The researchers achieved higher quality castings by changing the architecture of the runners (the passages along which molten metal flows into the die) and the gate (the narrow opening to the die cavity). "Our improved melt delivery systems are cost-effective, can be used with existing casting machines, and can significantly reduce the mass of the metal runner, wasting less metal. "They represent new 'green' die casting technologies, which are low-energy and are highly effective."

Gases captured during the passage of the molten metal into the die cavity cause porosity, which together with voids created during solidification, reduces the quality of the casting. Die castings with low porosity are stronger and can be successfully heat treated post-casting to improve their mechanical properties. The dynamic gating system (DGS) incorporates a gate capable of changing its size in response to the pressure of the melt during filling.

"Our improved melt delivery systems are cost-effective, can be used with existing casting machines, and can significantly reduce the mass of the metal runner, wasting less metal"

X-ray analysis of test castings showed a significant improvement in density in both thicker and thinner areas of the casting, when the dynamic gate was used.

ATM technology uses a revolutionary melt delivery system for the high pressure die casting (HPDC) process, which is cheaper to operate than conventional HPDC. The ATM casting technology has been proven by a number of companies in commercial production, and its effectiveness in reducing both shot weight and reject rates has been demonstrated.

"ATM conditions the melt prior to filling the cavity so that the melt enters the die in a less viscous, 'runnier' state," Dr O'Donnell said. "As a result, melt flow is improved and separate melt fronts fuse together better when they meet within the casting."

The outcome is a casting with a more uniform distribution of nucleation sites, a refined, homogenous microstructure, and exceptionally low porosity. CSIRO seeks commercial partners interested in licensing either the dynamic gating system or the ATM melt delivery system.

http://www.innovations-report.com

CHINA

High yield rice gene cloned

With the support of the Chinese Ministry of Agriculture, Ministry of Science and Technology, and National Natural Science Foundation, a team, led by LI Jiayang, a CAS academician and research fellow at CAS Institute of Genetics and Developmental Biology, and QIAN Qian, a research fellow at the Chinese Academy of Agricultural Sciences Institute of Rice, has successfully cloned a major high yield gene named IPA1 from a desired rice species. Researchers found that the mutation of IPA1 would result in the reduced rice tillering activities, but in an increased thousand-grain-weight. Meanwhile, the rice stalk would become thick and stout, resistant to lodging. Experiments show that regular rice species, when implanted with the mutated gene, will be able to claim a yield increase by 10% or more. The finding was published in the recent issue of *Nature Genetics*.

http://www.most.gov.cn

Carbon-fiber localization

A project to develop polymerization techniques for producing high performance Polyacrylonitrile (PAN)-based carbon fiber, undertaken by Ha'erbin Tianshun Chemicals, has recently passed the experts' approval. The project has achieved innovative developments in a number of areas. Researchers enhanced polymer spinability, and developed the techniques able to produce high performance PAN-based carbon fibers using the 3-element low temperature polymerization technique. They worked out the patented 3-element hardening and shaping techniques to enhance the properties of raw fibers. The enhanced fibers enjoy a reduced pre-oxidation temperature and a steady carbonization process, which in turn cuts down fiber defects in the carbonization process. The reduced temperature has hit the bottom of the temperatures applied for polymerization in the industry. The innovation made the techniques applied meet the criteria of energy efficiency and emission reduction. Researchers also developed a raw fiber oil agent that has been test proved by Beijing Chemistry University desirable for pre-oxidation, without sticking

and coking, with a dust rate less than 0.45%. Meanwhile, a vertical gradient washing facility, derived from the same effort, is a unique system in the country, enjoying the merits of energy efficiency and environmental protection.

The project has established a pilot production line with an annual capacity of 20 tons of high performance PAN-based carbon fiber, and has completed the test run of the production line, with high performance raw carbon-fibers produced up to the required standard.

http://www.most.gov.cn

DPR KOREA

Nano agro-sterilizer

Democratic People's Republic of Korea (DPRK) researchers have developed an effective agro-sterilizer using nano-technology, official news agency KCNA reported. KCNA said the sterilizer was developed by the Academy of Agricultural Science and used bactericidal elements that were nano-processed separately and mixed before use. It was sprayed mainly on seeds in treatment and crops during the growing period to prevent diseases taking hold.

Some farms said the effect of a little amount of sterilizer was higher than tens of kilograms of iron sulphate, according to the Central Information Agency for Science and Technology. The sterilizer has also been used to kill harmful insects during cultivation of rice, bean, cucumber and red pepper.

http://news.xinhuanet.com

JAPAN

Protein molecule for improved stability and affinity

Shinya Honda (Leader), Molecular and Cellular Breeding Research Group, the Institute of Biological Resources and Functions of the National Institute of Advanced Industrial Science and Technology (AIST) and his colleagues modified a protein that is used in the purification of therapeutic antibodies (so-called antibody drugs) based on molecular design and improved the stability and affinity of the protein.

The engineered protein was developed in two stages. First, the amino acid sequences were designed to stabilize the molecular structure of Protein G (first generation). Then the stabilized Protein G molecules were further modified to improve molecular recognition properties such as affinity (second generation).

In the first-generation design, the amino acid sequences were generated by inputting the atomic coordinates of wild-type (unmodified) Protein G structure into an originally developed molecular design program. According to the output from the program, several types of engineered Protein G were synthesized. All engineered Protein G molecules showed increases of 7 to 13°C in heat resistance, 1.4 to 1.6 times increases in chemical resistance against denaturants, and 4 to 14 times increases in resistance against proteases. Because increases in the stability of a protein molecule lead to improved durability of the protein as an affinity ligand in the purification process, protein stabilization is a key to developing a low-cost system of antibody-drug production. The 3D structure of one of the engineered proteins was then determined by X-ray crystallography. In parts other than the engineered region, the atomic coordinates (3D structure of the molecule) of the protein were almost the same as those of wild-type Protein G.

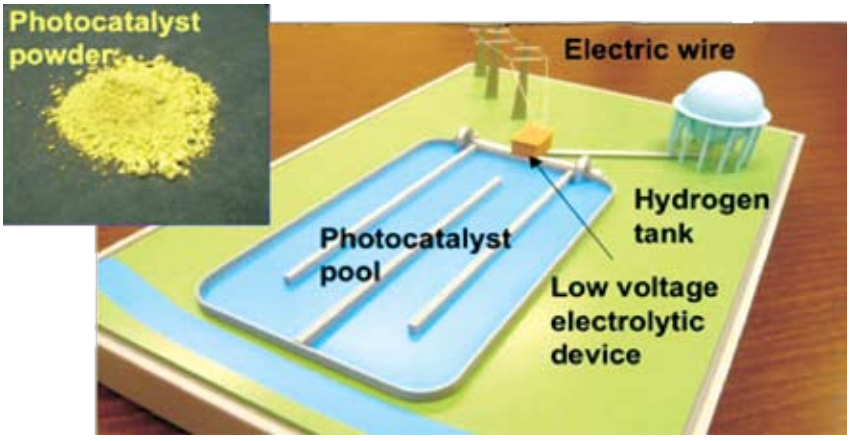
In the second-generation design, the computer model structure of a complex of the first-generation engineered Protein G and the antibody IgG1 was built from their 3D structures. From this model, we redesigned the amino acid sequence to improve the affinity by conducting computer simulations including that of electrostatic repulsion at the contact interface between the engineered Protein G and IgG1 within the complex. The redesigned engineered Protein G was synthesized and its properties were examined. The antibody affinity at neutrality was found to be 11 times higher, and the pH response (evaluated by comparing the affinities at neutral and acidic conditions) was 18 times that of wild-type Protein G.

Then the behaviors of the affinity chromatography, in which the second-generation engineered Protein G is used as an affinity ligand, were investigated by using an already approved antibody drug. The engineered protein was found to shift the pH of the peak elution of the adsorbed antibody drug to the neutral side, from pH 3.1 to pH 4.1. Because purification under moderate conditions reduces the risk of antibody-drug degradation during production, it is indispensable to enable purification to be performed under milder conditions in order to secure the quality of antibody drugs. Furthermore, the second-generation engineered Protein G was shown to have sufficient affinity for all subclasses of human IgG.

http://www.aist.go.jp

High-performance photocatalyst

Kazuhiro Sayama (Leader), Yugo Miseki (Research Scientist), et al. of Solar Light Energy Conversion Group, the Energy Technology Research Institute of the National Institute of Advanced Industrial Science and Technology (AIST), developed a tungsten oxide (WO_3) photocatalyst that provides a significantly higher quantum yield under visible light than conventional photocatalysts. A photocatalyst-electrolysis hybrid system using this photocatalyst is a hydrogen production system in which solar light is efficiently used. The AIST's original system employs the photocatalyst that generates oxygen by oxidizing water and reducing iron(III) ions (Fe^{3+}) to iron(II) ions (Fe^{2+}). The system also involves low-voltage electrolysis in which water is reduced



New high-performance photocatalyst (upper left) and an overall model of the photocatalyst-electrolysis hybrid system

to generate hydrogen and Fe^{2+} ions are oxidized to Fe^{3+} ions.

The high efficiency of the WO_3 photocatalyst was achieved using a new method — treatment of the surface of the photocatalyst with Cesium (Cs). The activity of the treated catalyst is more than ten times that of untreated catalysts. The quantum yield of the new photocatalyst is 19% under visible light of wavelength 420 nm and is approximately 50 times the previously reported values (0.4%). The use of solar energy can reduce the voltage required for water electrolysis by almost 50%. Hence, the low-cost production of hydrogen is expected.

A photocatalytic reaction converting solar energy is used to lower the electrolysis voltage required for the hydrogen production by water electrolysis.

http://www.aist.go.jp

THE PHILIPPINES

Biodiesel from *Jatropha curcas*

In support of the Philippine Biofuel law and the Alternative Fuels Program of the government, the Industrial Technology Development Institute (ITDI) of the Department of Science and Technology (DoST) has recently launched its new facility for the pilot production and testing of biodiesel from *Jatropha curcas.* The Philippine National Oil Corporation-Alternative Fuels Corporation (PNOC-AFC) and the Philippine Council for Industry and the Energy Research and Development (PCIERD) of the DoST are also behind the jatropha oil production project. *Jatropha curcas* is locally called "tubing bakod." It grows sporadically as hedges or abandoned crops. It has been discovered as an alternative source of renewable fuel.

Situated in DoST Compound, Bicutan, Taguig, the facility has an approximate area of 140 square meters and is equipped with a decorticating machine, oil expeller, filter press, boiler, neutralization tanks, transesterification equipment, separate broiler, and a wastewater treatment tank. Some of the machines were imported from India.

For the pilot production, more than two metric tons of *Jatropha curcas* seeds were used to produce jatropha oil. The yield of oil was about 12.83 percent to 22 percent, while the processing of jatropha oil into Jatropha Methyl Ester (JME) resulted to approximately 85 percent to 89 percent yield. They are currently doing some tests on blending JME with diesel.

According to the ITDI, the production of JME would also generate by-products like the pressed cake and glycerine. However, these wastes can be developed in high-value products. If the pressed cake is blended with bone meal and coir dust, it becomes a natural fertilizer. Clean gas and fuel composite can also be produced from jatropha pressed cake, while crude glycerine can be refined into industrial grade.

In order to make this kind of facility more accessible to the public, the concerned agencies are working with the Metals Industry Research and Development Center (MIRDC) of the DoST to produce a local prototype of jatropha oil expeller. If more jatropha processing equipment will be developed, more communities will be able to benefit from it. Local fabricators are now being tapped by the agencies to make these prototypes.

http://www.mb.com.ph

EUROPE

DENMARK

Mass production of polymer solar cells

Ten years of intensive research and development at Risoe DTU (Technical University of Denmark) is now materialized in a fully operational production line for polymer solar cells at the Danish company Mekoprint A/S. Polymer solar cells which is an inexpensive alternative to silicon solar cells, has a significant industrial potential.

Production of polymer solar cells starts from a roll of flexible foil onto which the solar cell is built layer by layer by printing and finally rolled up onto the coil again. Encapsulated and ready-to-use units can thereafter be cut from the roll and according to the customer's specification. As the whole process from feedstock to finished product is performed roll-to-roll, the new production line paves the way towards mass production of solar cells and thereby correspondingly low prices.

Risoe DTU has supplied the printing technology as a complete package consisting of a custom-made printing head, inks for printing the solar cell's various layers and training of opera-

tors. Mekoprint has contributed with an established industrial infrastructure and their core technology which is industrial roll-to-roll production.

Professor at Risoe DTU Frederik C. Krebs is the driving force behind the Danish polymer solar cells. Ten years ago he started out with a bright idea, his two hands and a strong dedication. Today Frederik Krebs is the head of an international leading research team counting more than 25 persons - a team capable of combining world-class science with a strong desire to bring science out into real life. The Risoe team distinguishing themselves by being first to demonstrate new and innovation applications for the polymer solar cell: "The Solar Hat" - a hat powering a small FM radio (Roskilde Festival 2008), a solar-powered reading lamp for African schoolchildren (Zambia 2009) and the world's first grid-connected PV installation based on the polymer technology (Risoe 2009).

Risoe's and Mekoprint's staff have over the last months worked hard to rebuild one of Mekoprint's existing printing line to the new production, and the very first solar cells from this line were produced on 22 June 2010. A line producing polymer solar cell is an important incentive for continuing the activities at Risoe DTU. The polymer solar cell technology is still young and immature compared to the 50-year old silicon technology. The gap between the two technologies is to be gradually reduced by focused research and development, and this task is already addressed by the Risoe team.

http://www.physorg.com

GERMANY

Nanopores make sterile filtration more reliable

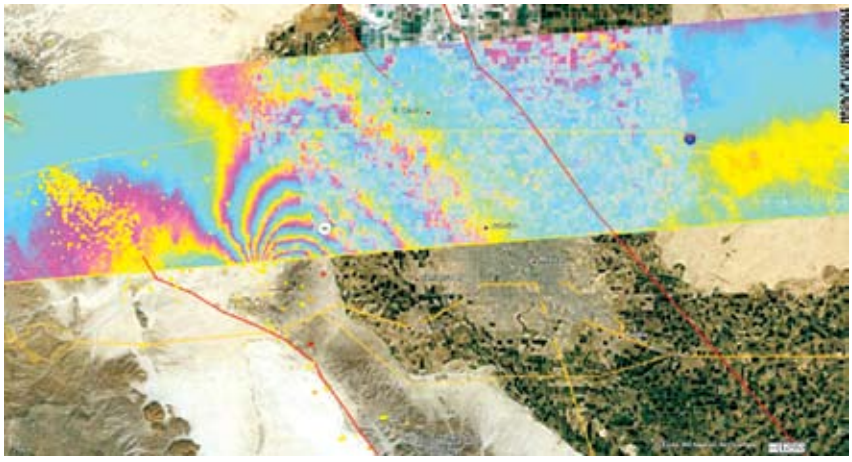
Irregular pores, low flow rates: The plastic membrane filters used in sterile filtration do not always ensure that conditions are really sterile. Filter membranes of aluminum oxide are more reliable – the size of the nanopores can be determined with precision. Even the smallest viruses cannot pass through the membrane.

This mechanically stabilized nanoporous filter membrane exhibits a regular pore structure. At the same time, the pore size distribution is very tight and even. (© Fraunhofer IWM)

The good ones are kept, the bad ones done away with – that, in a nutshell, is the principle behind sterile filtration: A filtration membrane frees liquids of unwanted particles and germs. Nothing larger than the filter's pores, only a few ten-thousandths of a millimeter in diameter, can pass through. Conventional membranes, usually made of plastic, come with limitations: Their pores are not evenly distributed and are occasionally too wide – and particles slip through after all. Conventional filtration membranes also have virtually no way of stopping viruses, because most viruses are smaller than the pores, this technology offers no way to filter them out.

Now, researchers at the Fraunhofer Institute for Mechanics of Materials IWM in Halle, Germany, have created a new generation of filtration membranes. They developed ceramic membranes with a uniform pore structure and a very tight and even pore size distribution. "Compared to the ceramic membranes we have seen previously, they offer better mechanical stability and considerably higher flow rates. As a result, for the first time they are also able to replace polymer membranes", notes Annika Thormann, project manager at IWM. These membranes guarantee much more reliable filtration results than polymer membranes do. Electron microscope images of the membranes prove that the pores are regularly aligned alongside one another like the honeycombs in a beehive, one identical to the next.

To produce such filtration membranes, what is required first is the right raw material: "We use highly pure aluminum that we mold to the desired shape using extrusion equipment and thermomechanical structuring", Thormann explains. But just how can you create tiny pores on an aluminum plate with such precision? "A chemical reaction does the job", Thormann says. The molded aluminum part is placed in an acid bath where anodic oxidation takes place. An oxide layer just a few microns thick forms on the surface during electrolysis. 'Tiny pores form in the aluminum during oxidation," Thormann explains. These nanopores are honeycomb-shaped, vertical to the surface, and are arrayed parallel to one another. 'To set the pore size, we have to keep the voltage and the concentration of the acid stable", Thormann notes. The thickness of the nanoporous layer – and hence the flow rate of the membrane itself – can be fine-tuned as well via the duration of the oxidation process. In the end, the only step remaining is to open up the



An interferogram of the April quake in Baja California is overlaid atop a Google Earth image of the region.

pores. This step is accomplished with chemical etching to remove unneeded residual aluminum.

The result: High-precision filtration membranes with a high porosity level. "We can vary pore diameters between 15 and 450 nanometers", says Thormann. At 15 nanometers, even the smallest viruses don't stand a chance of slipping through. The new filtration membranes are particularly beneficial to biotechnology. Aside from use of the filtration properties to produce sterile media the membranes can also facilitate tissue engineering – the cultivation of artificial tissue – thanks to their high porosity.

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NORTH AMERICA

USA

New technology for earthquake prediction

A team of scientists at NASA's Jet Propulsion Laboratory, in Pasadena, California, has developed a new imaging technology that could one day lead to the prediction of earthquakes. The new airborne radar-based mapping technology allows scientists to see earthquake images on the ground for the first time.

"Hurricane imaging has 40 years on us. In the 60's they got the first satellite images of hurricanes. So now we're in 2010, and we have the first airborne image of an earthquake," said Andrea Donnellan, a geophysicist with the NASA lab. Donnellan is part of the team developing the new imaging system. Donnellan said this is the beginning of studying earthquake fault systems, like weather prediction systems, which are mapped and studied.

The new earthquake maps show the deadly movement of the ground during the 7.2 magnitude quake that struck Baja California in early April. The interferogram images, which are a photographic record of light interference patterns, shows colorful images of lines in undulating butterfly-patterned lines and dots in psychedelic colors. The maps were collected from a Gulfstream-III aircraft equipped with a radar antenna on it. The pilots had actually been making measurements over the area in southern California since the spring of 2009.

"So what we've done is we flew over that same line after the April earthquake and looked at how the ground moved," Donnellan told CNN Radio. The interferogram "shows us how radar waves between two passes of the airplane interfere with each other. So when the ground moves you get these fringe patterns. They're kind of tree rings in a tree. The more tree rings you have, the older the tree is. The more fringes you have, the more ground motion there was."

The airborne images show tiny or large motions that occurred beneath the surface of the earth, on the fault line, which can't be seen by flying over an area or walking on the surface. Donnellan explains scientists can use the maps to determine how the fault lines are behaving.

"We combine the surface image with the computer models to find out what the faults are doing at depth," Donnellan said. What about predicting an earthquake or creating a warning system like those used for tornadoes? "We're not doing short-term forecasting of earthquakes yet.....It's going to take years of observation and years of studying earthquakes to see what we can detect. But we're pretty confident that we can improve the current hazard maps, which have 30 year-type outlooks, to five to ten year outlooks. And if you have that, you can start to prioritize where you retrofit your buildings and bridges and dams, so that they're more earthquake safe," Donnellan said.

http://www.cnn.com

Using carbon nanotubes in lithium batteries

Batteries might gain a boost in power capacity as a result of a new finding from researchers at MIT. They found that using carbon nanotubes for one of the battery's electrodes produced a significant increase, up to tenfold, in the amount of power it could deliver from a given weight of material,

compared to a conventional lithium-ion battery. Such electrodes might find applications in small portable devices, and with further research might also lead to improved batteries for larger, more power-hungry applications.

To produce the powerful new electrode material, the team used a layer-by-layer fabrication method, in which a base material is alternately dipped in solutions containing carbon nanotubes that have been treated with simple organic compounds that give them either a positive or negative net charge. When these layers are alternated on a surface, they bond tightly together because of the complementary charges, making a stable and durable film.

The findings, by a team led by Associate Professor of Mechanical Engineering and Materials Science and Engineering Yang Shao-Horn, in collaboration with Bayer Chair Professor of Chemical Engineering Paula Hammond, are reported in a paper published June 20 in the journal *Nature Nanotechnology*. The lead authors are chemical engineering student Seung Woo Lee and postdoctoral researcher Naoaki Yabuuchi.

Batteries, such as the lithium-ion batteries widely used in portable electronics, are made up of three basic components: two electrodes (called the anode, or negative electrode, and the cathode, or positive electrode) separated by an electrolyte, an electrically conductive material through which charged particles, or ions, can move easily. When these batteries are in use, positively charged lithium ions travel across the electrolyte to the cathode, producing an electric current; when they are recharged, an external current causes these ions to move the opposite way, so they become embedded in the spaces in the porous material of the anode.

In the new battery electrode, carbon nanotubes — a form of pure carbon in which sheets of carbon atoms are rolled up into tiny tubes — "self-assemble" into a tightly bound structure that is porous at the nanometer scale (billionths of a meter). In addition, the carbon nanotubes have many oxygen groups on their surfaces, which can store a large number of lithium ions; this enables carbon nanotubes for the first time to serve as the positive electrode in lithium batteries, instead of just the negative electrode.

http://www.innovations-report.com

Super-high pressures to create super battery

The world's biggest Roman candle has got nothing on this. Using super-high pressures similar to those found deep in the Earth or on a giant planet, Washington State University (WSU) researchers have created a compact, never-before-seen material capable of storing vast amounts of energy.

"If you think about it, it is the most condensed form of energy storage outside of nuclear energy," says Choong-Shik Yoo, a WSU chemistry professor and lead author of results published in the journal *Nature Chemistry*.

The research is basic science, but Yoo says it shows it is possible to store mechanical energy into the chemical energy of a material with such strong chemical bonds. Possible future applications include creating a new class of energetic materials or fuels, an energy storage device, super-oxidizing materials for destroying chemical and biological agents, and high-temperature superconductors.

The researchers created the material on the Pullman campus in a diamond anvil cell, a small, two-inch by three-inch-diameter device capable of producing extremely high pressures in a small space. The cell contained xenon difluoride (XeF_2), a white crystal used to etch silicon conductors, squeezed between two small diamond anvils.

At normal atmospheric pressure, the material's molecules stay relatively far apart from each other. But as researchers increased the pressure inside the chamber, the material became a two-dimensional graphite-like semiconductor. The researchers eventually increased the pressure to more than a million atmospheres, comparable to what would be found halfway to the center of the earth. All this "squeezing," as Yoo calls it, forced the molecules to make tightly bound three-dimensional metallic "network structures." In the process, the huge amount of mechanical energy of compression was stored as chemical energy in the molecules' bonds.

http://www.physorg.com

Photosynthetic bacteria to produce sugar

Researchers from the Wyss Institute for Biologically Inspired Engineering at Harvard and Harvard Medical School have developed a method to produce sugar from photosynthetic bacteria. The innovation could reduce the carbon dioxide emissions associated with transporting sugar globally from producing countries; lead to greater availability of biodegradable plastics; and allow capture of harmful CO_2 emissions from power plants and industrial facilities.

Moreover, the technology offers potential economic advantages. Because the production methods use photosynthesis - the process by which living things are assembled using only CO_2 and sunlight the cost of making sugars, lactic acid, and other compounds would be significantly lower than traditional methods.

Wyss Institute senior staff scientist Jeffrey Way, said: "What we're doing is using genetic engineering to get organisms to act the way we want them to — in this case producing food additives. These discoveries have significant practical implications in moving toward a green economy."

http://sify.com