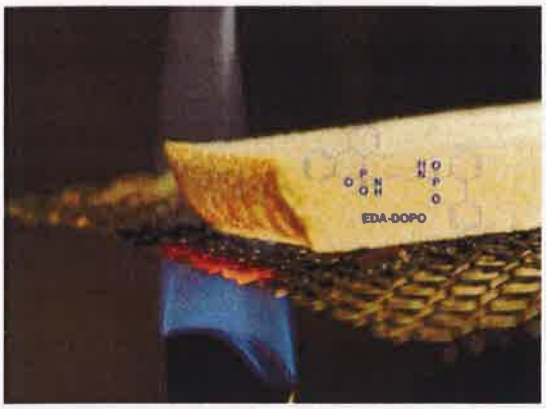
3. Machinery That Repairs Itself

In the EU-funded project SelSus, Fraunhofer scientists are collaborating in a consortium with partners from research and industry to develop maintenance technology capable of forecasting machine downtimes in production before they occur. This allows plant managers to rectify faults before the machine breaks down. The system even corrects some defects automatically. Unforeseen machine failures during ongoing production -- plant managers dread them, technicians detest them and managers just sigh and factor them in. Such incidents prompt frantic repairs, drive up costs, adversely affect delivery reliability and ultimately weaken companies' competitiveness. Yet often the problem is only a small defect or normal wear and tear. However, if left undetected, these can lead to major disruptions and production downtimes. What would be helpful is a diagnostic procedure capable of monitoring the status of all components in the production line, identifying problems and weak points and informing the responsible employee in a timely manner. Based on what's known as a decision-support system, maintenance personnel can then reach a decision and take targeted action to repair the defect. Ideally without having to interrupt production. Precisely this is one of the underlying ideas, albeit not the only one, behind the ambitious SelSus project within which the Fraunhofer Institute for Manufacturing Engineering and Automation IPA is currently researching. "The aim is not just to monitor the status of the machines and components. Using intelligent software and sensor networks, the plan is to detect potential weak points or signs of wear and tear early enough for the system to be able to predict potential malfunctions," explains Martin Kasperczyk from Fraunhofer IPA. The developed diagnostic models also directly provide suggestions or recommendations on how to rectify the problem. Project partner Electrolux in Pordenone, Italy, uses such a decision-support system. The system is capable of predicting with a certain probability potential failures on a press for washing machine facings and of diagnosing actually occurring malfunctions. The data needed to monitor the machine status is partially provided by sensors. They measure values such as energy consumption, temperature, oil pressure, particles in the oil or vibrations. Fraunhofer IPA and the participating consortium have also proved that the technology functions reliably in practice. The system is even capable of sending control impulses to individual machines. A welding control on which a sensor has failed, for instance, can continue to work almost seamlessly in a secure mode, without any serious disruptions. The capability for self-repair and sustaining production has also given the project its name. The full project title of SelSus is "Health Monitoring and Life-Long Capability Management for Self-Sustaining Manufacturing Systems." However, first a number of technological hurdles had to be overcome. Martin Kasperczyk says: "One of the biggest challenges was analyzing the flood of data. After all, we're talking here about predicting malfunctions or breakdowns of machines with a high degree of reliability. You don't get there just by programming a couple of algorithms." The experts are putting their faith in Bayesian networks. A Bayesian network is a mathematical model that can be used to compute the probabilities of a certain event or state occurring. The model represents a set of variables and their conditional dependencies. With the help of the data collected by the sensors, the software for example computes the probabilities of a specific high-stress cable breaking in the near future and, where applicable, signals that it should be replaced. But the SelSus software relies not only on sensors. It also takes the technical characteristics of the machine and its performance parameters into account. This data has to be captured during installation and configuration of the system. Moreover, an extensive test run tells the system how the machine and its components behave in continuous operation and under load. Only then is it ready for use. The software also registers new data, for instance as a result of machine upgrades or deterioration in performance due to wear, enabling the system to learn. The complexity of the SelSus concept is also evident from the fact that the software even interacts with operators by analyzing the causes of potential or existing malfunctions and proposing an appropriate course of action. Project partner The Manufacturing Technology Centre from Coventry, UK, has created a system with self-healing capabilities. In an engine production plant, a dispenser is attached to a robotic arm by means of vacuum. If the dispenser encounters resistance, rather than snapping off, it reacts flexibly. It loses the grip produced under vacuum and drops a few centimeters until it is stopped by springs. The springs then draw the dispenser back to its original position. Subsequent calibration ensures the tool is in the correct position -- and after the brief interruption, the work process continues.

Source https://www.sciencedaily.com/releases/2017/10/171005103844.htm

Chemical Engineering

4. Non-Toxic Flame Retardant Enters Market, Study Suggests



Foam sample with EDA-DOPO in a flame test in the EMPA laboratory.

Chemists from Empa have developed and patented an environmentally friendly way to produce flame retardants for foams that can be used in mattresses and upholstery. Unlike previous flame retardants made of chemicals containing chlorine, the new material is non-toxic and effective. EDA-DOPO, the environmentally friendly flame retardant developed at Empa, is going into serial production. The newly developed, particularly economic and ecological synthesis method, which also simplifies the production of other DOPO derivatives, is a crucial part of this success story. The company Metadynea Austria GmbH will manufacture the material and, if there is sufficient demand, the global FoamPartner Group will use it to produce flame-retardant polyurethane (PU) foams for upholstery and mattresses. This constitutes the first step towards replacing conventional, halogenated flame retardants, which are sometime toxic and give off toxic gases in the event of a fire. Empa's EDA-DOPO -- a derivative of the familiar flame retardant DOPO (9,10-dihydro-10-oxa-phosphaphenanthreneoxide) -- does not emit these toxins. Furthermore, the foam material containing this flame retardant satisfies the highest flame retardant classification (UL 94 HB). Fire retardant expert Sabyasachi Gaan developed EDA-DOPO at Empa in a two-year research project within the scope of the Eureka SUSPUR project. It was initiated by the FoamPartner Group, which was looking to expand its range with environmentally friendly flame retardant PU foams. The company is currently the sole license holder for EDA-DOPO for PU applications. The substance is manufactured exclusively by Metadynea Austria GmbH. Flame-retardant upholstery is especially mandatory for areas where many people gather: Planes, trains, buses, hotels and restaurants. Flame retardants prevent materials from being ignited, such as with cigarettes or by vandals. However, the environmental standards keep getting stringent here, too. The evaporation of flame retardants into the ambient air or atmosphere is undesirable and the toxic gases that can form during a fire are also being accepted less and less. Many countries have already banned halogenated flame retardants. Consequently, there is a growing need for modern, harmless alternatives all over the world. Although foam production with the new flame retardant is already underway, products containing EDA-DOPO will not be on sale just yet; the flame retardant is currently being certified in accordance with the European chemical regulation REACH. The foam samples produced are presently undergoing diverse flame tests to enable the new flame-retardant foams to hit the global markets as quickly as possible once they obtain their REACH certification. We encounter PU foams in many places in everyday life: They are in the insulation on house façades, fridges, car seats, living room sofas and shoe soles. PU is composed of carbon, hydrogen, nitrogen and oxygen atoms. The air trapped in the foam's pores also contains oxygen. Therefore, the foam -- like most organic polymers -- is highly flammable and, depending on the requirements, needs to be equipped with flame retardants to curb the risk of fire. In recent decades, foam manufacturers tended to use chlorinated phosphates as flame retardants -- low-priced substances that do not disrupt the production process. However, many of these chlorinated flame retardants are toxic and can eventually evaporate from the foam and get into the ambient air. As a result, these substances are already banned in many countries. Industry is thus on the lookout for environmentally friendly, harmless alternatives. And it's big business: Every year, around 20 million tons of PU foam are produced worldwide, the majority of which is supposed to be equipped with flame retardants. EDA-DOPO satisfies economic and ecological criteria with flying colours and has achieved the highest flame retardant classification UL 94 HB. The flame retardant is also highly compatible with the production process for PU foams: It mixes well with polyol, a base material of PU foam, and forms a stable dispersion. The production process results in a foam with the solid flame retardant EDA-DOPO finely distributed in its pores.

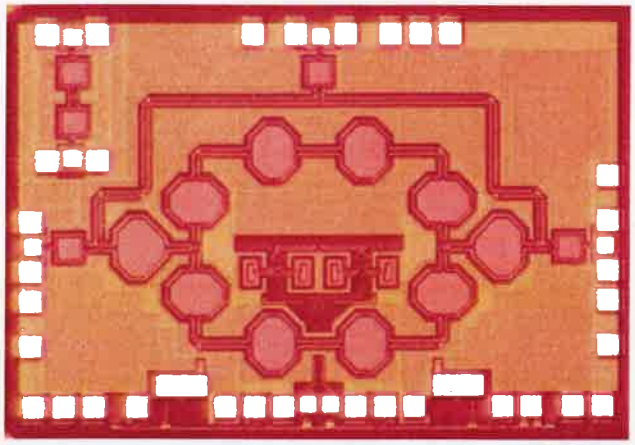
Source https://www.sciencedaily.com/releases/2017/09/170928085147.htm

5. Using Elastomer Films to Generate Electricity

Water is still the most important source of renewable energy in Bavaria, Germany, accounting for some 33 percent of all renewable energy produced in the region, as showed by the Bavarian Energy Map. But conventional hydroelectric plants, especially micro hydro generators, are a subject of controversy due to their low output volumes and their interference with the ecosystem. Fraunhofer researchers are working on an environmentally friendly alternative: in the future, innovative elastomer materials are set to convert the mechanical energy produced by flowing water in small rivers directly into electrical energy. In the DEGREEN project, the Fraunhofer Institute for Silicate Research ISC is pursuing an innovative approach to renewable energy generation using hydropower. To this end, the Würzburg-based researchers are using highly flexible and ultra-thin elastomer films that work as capacitors. The silicone films are coated on both sides with a conductive elastic layer and furnished with a protective layer of insulation. They are installed in small rivers and streams where the constant deformation and relaxation of the elastomers converts the mechanical kinetic energy from the water directly into electrical energy. The flowing water deforms the soft film, the characteristics of which are similar to those of a balloon. When deformed, the films carry a high electric charge generated by the stretching process. The elastomer film is then mechanically relaxed to its original state. "At this point, a high volume of electrical energy has been generated and charges a temporary storage device on an integrated circuit. It is from here that we siphon the energy. This deformation and relaxation cycle is repeated once a second," explains Dr. Bernhard Brunner, project manager and scientist at Fraunhofer ISC. "If we apply a potential of 4000 volts, for each deformation we can generate 100 milliwatts of electrical power per film." But how is this cyclic deformation of the films achieved? Brunner and his team have implemented a smart mechanical excitation concept. Water flows through a constricted tube building up negative air pressure -- a concept also known as the Venturi effect -- which causes the elastomer film to deform. An air valve is then opened to equalize the negative air pressure and the elastomer film returns to a non-deformed state. What makes the design so ingenious is that the air vent is self-controlled: it opens and closes on its own without requiring electronics or power. Changing the diameter of the film enables the researchers to adjust the pressure. Consequently, the generator can be adapted to the flow rate. Comprising films, tube, vent, pump, air duct, electronics and rectifier, the overall system has a modular structure. The tubes, which also have a flexible diameter, are adjusted according to the depth and width of the water and are set up either on top, behind or next to one another. If a river is wide but shallow, it is recommended to mount the tubes next to each other. "One major advantage of our concept is its flexibility: it can be used in water of any depth. We harness the water's fluid energy. Our elastomer generators are ideal for small rivers and can be operated at flow velocities from as low as 0.5 meters per second and at depths of 0.5 meters. In Bavaria, there are some exceptionally small rivers which together cover a length of some 30,000 kilometers. Our system, which is not influenced by wind or sun, is the perfect solution. The elastomer generators are designed to operate silently in shallow and small waters without a check dam. They are suitable, for example, for use as a decentralized power supply for campsites or remote settlements located in the immediate vicinity of water. In the lab, Brunner and his team are currently developing two types of generator: one that floats and one that is fixed to the riverbank. They are currently working on miniaturizing the generator's size. By the end of the project, they expect to come out with a weather- and flood-proof system that is about the size of a switch control box.

Source https://www.sciencedaily.com/releases/2017/10/171005103533.htm

6. Engineers Invent Breakthrough Millimeter-Wave Circulator IC



This is a chip microphotograph of the 25GHz fully-integrated non-reciprocal passive magnetic-free 45nm SOI CMOS circulator based on spatio-temporal conductivity modulation.

Columbia Engineering researchers, led by Harish Krishnaswamy, associate professor of electrical engineering, in collaboration with Professor Andrea Alu's group from UT-Austin, continue to break new ground in developing magnet-free non-reciprocal components in modern semiconductor processes. Krishnaswamy's group recently unveiled a new device: the first magnet-free non-reciprocal circulator on a silicon chip that operates at millimeter-wave frequencies (frequencies near and above 30GHz). Most devices are reciprocal: signals travel in the same manner in forward and reverse directions. Nonreciprocal devices, such as circulators, on the other hand, allow forward and reverse signals to traverse different paths and therefore be separated. Traditionally, nonreciprocal devices have been built from special magnetic materials that make them bulky, expensive, and not suitable for consumer wireless electronics. The team has developed a new way to enable nonreciprocal transmission of waves: using carefully synchronized high-speed transistor switches that route forward and reverse waves differently. In effect, it is similar to two trains approaching each other at super-high speeds that are detoured at the last moment so that they do not collide. The key advance of this new approach is that it enables circulators to be built in conventional semiconductor chips and operate at millimeter-wave frequencies, enabling full-duplex or two-way wireless. Virtually all electronic devices currently operate in half-duplex mode at lower radio-frequencies (below 6GHz), and consequently, we are rapidly running out of bandwidth. Full-duplex communications, in which a transmitter and a receiver of a transceiver operate simultaneously on the same frequency channel, enables doubling of data capacity within existing bandwidth. Going to the higher mm-wave frequencies, 30GHz and above, opens up new bandwidth that is not currently in use. "This gives us a lot more real estate," notes Krishnaswamy, whose Columbia High-Speed and Mm-wave IC (CoSMIC) Lab has been working on silicon radio chips for full duplex communications for several years. His method enables loss-free, compact, and extremely broadband non-reciprocal behaviour, theoretically from DC to daylight, that can be used to build a wide range of non-reciprocal components such as isolators, gyrators, and circulators. "This mm-wave circulator enables mm-wave wireless full-duplex communications, Krishnaswamy adds, "and this could revolutionize emerging 5G cellular networks, wireless links for virtual reality, and automotive radar." The implications are enormous. Self-driving cars, for instance, require low-cost fully-integrated millimeter-wave radars. These radars inherently need to be full-duplex, and would work alongside ultra-sound and camera-based sensors in self-driving cars because they can work in all weather conditions and during both night and day. The Columbia Engineering circulator could also be used to build millimeter-wave full-duplex wireless links for VR headsets, which currently rely on a wired connection or tether to the computing device. "For a smooth wireless VR experience, a huge amount of data has to be sent back and forth between the computer and the headset requiring low-latency bi-directional communication," says Krishnaswamy. "A mm-wave full-duplex transceiver enabled by our CMOS circulator could be a promising solution as it has the potential to deliver high speed data with low latency, in a small size with low cost." The team is currently working to improve the linearity and isolation performance of their circulator. Their long-term goal is to build a large-scale mm-wave full-duplex phased array system that uses their circulator.

Source https://www.sciencedaily.com/releases/2017/10/171006085919.htm

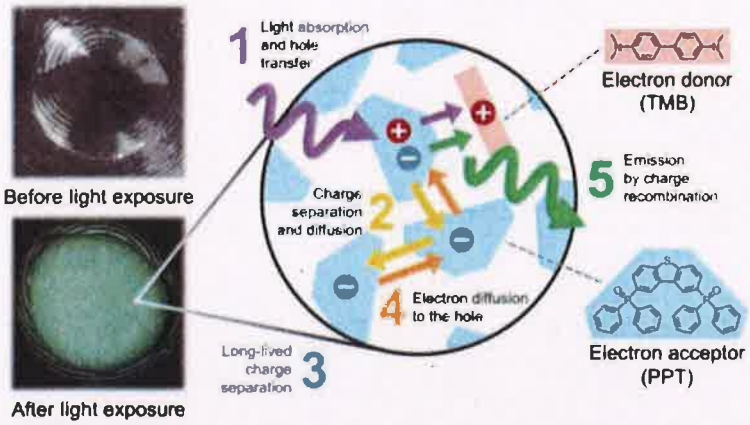
Aerospace Engineering

7. Step Toward Creating Planes That Travel at Hypersonic Speed

An average flight from Miami to Seattle takes about six hours and 40 minutes, but imagine being able to reduce that time to 50 minutes or less. A recent study by researchers at NASA and Binghamton University, State University of New York, could lead to a drastic decrease in flight times. The study, funded in part by the U.S. Air Force, is one of the first steps toward the creation of planes able to move at hypersonic speeds, five to 10 times the speed of sound. There are currently quite a few obstacles when it comes to building these super planes, said Binghamton University Associate Professor of Mechanical Engineering Changhong Ke. The first of which is finding a material that can hold up to hypersonic travel. "Our study used what are called boron nitride nanotubes (BNNTs). NASA currently owns one of the few facilities in the world able to produce quality BNNTs," said Ke. Typically, carbon nanotubes have been used in planes for their strength -- they're stronger than steel -- and their ability to conduct heat. However, BNNTs are the wave of the future when it comes to air travel. "While carbon nanotubes can stay stable at temperatures up to 400 degrees Celsius, our study found that BNNTs can withstand up to 900 degrees Celsius," said Ke. "BNNTs are also able to handle high amounts of stress and are extremely lightweight." Withstanding high temperatures is an important requirement for any material meant to build the world's next super planes. However, Ke clarified that the material has to be able to maintain both structural and mechanical properties in an oxygen environment. "We weren't testing this material in a vacuum, like what you would experience in space. Materials can withstand much higher temperatures in space. We wanted to see if BNNTs could hold up in the type of environment an average fighter jet or commercial plane would experience," he said. While the study has brought new light to the strength and stability of BNNTs, their use on planes may not be a reality for another five to 10 years. "Right now, BNNTs cost about $1,000 per gram. It would be impractical to use a product that expensive," said Ke. But, that does not mean it will never happen. Carbon nanotubes were about the same price 20 years ago. As more studies indicated the usefulness of carbon nanotubes, the production rates increased and prices went down to the current rate, between $10 and $20 per gram. Ke sees the same fate coming down the line for BNNTs. Ke plans to continue this type of research on BNNTs. While the advances of BNNTs will probably be used first in fighter jets, Ke said he can see this type of technology trickling down to commercial flights.

Source https://www.sciencedaily.com/releases/2017/10/171010152901.htm

8. Glowing News for Organic Materials

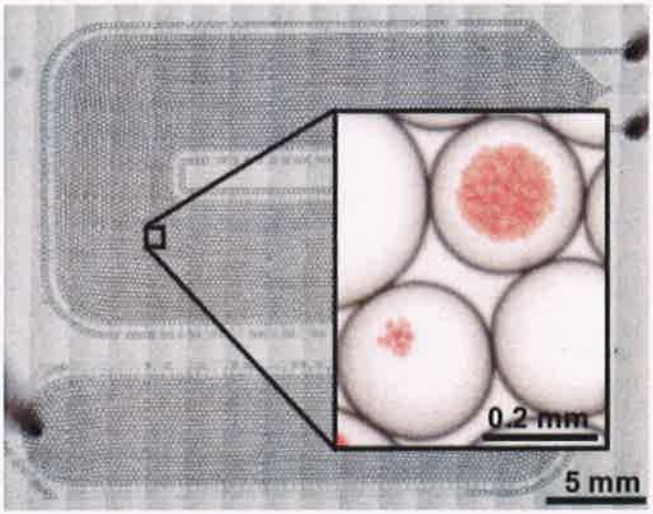


Glow-in-the-dark paints that have improved flexibility and transparency while also being cheaper and easier to manufacture are on the horizon courtesy of new research from Kyushu University. In a groundbreaking demonstration, light emission lasting more than one hour was achieved from organic materials, which are also promising for unlocking new applications such as in bio-imaging. Based on a process called persistent luminescence, glow-in-the-dark materials work by slowly releasing energy absorbed from ambient light. Used in watches and emergency signs, commercial glow-in-the-dark materials are based on inorganic compounds and include rare metals such as europium and dysprosium. However, these materials are expensive, require high temperatures to manufacture, and scatter light -- as opposed to being transparent -- when ground into powders for paints. Carbon-based organic materials -- similar to those used in plastics and pigments -- can overcome many of these disadvantages. They can be excellent emitters and are already widely used in organic light-emitting diodes (OLEDs). But achieving long-lived emission has been difficult, and the longest emission from organics under indoor lighting at room temperature was, until now, only a few minutes. Researchers at Kyushu University's Center for Organic Photonics and Electronics Research (OPERA) have now broken through this limit using simple mixtures of two appropriate molecules. In films formed by melting together molecules that donate electrons and ones that accept electrons, emission lasting for over an hour was demonstrated for the first time from organic materials without the need for intense light sources or low temperatures. "Many organic materials can use energy absorbed from light to emit light of a different colour, but this emission is generally fast because the energy is stored directly on the molecule that produces the emission," says Ryota Kabe, lead researcher. "By contrast, our mixtures store the energy in electrical charges separated over a longer distance. This additional step allows us to greatly slow down the release of the energy as light, thereby achieving the glow-in-the-dark effect." In the mixtures, absorption of light by an electron-accepting molecule, or acceptor, gives the molecule extra energy that it can use to remove an electron from an electron-donating molecule, or donor. This transfer of an electron is effectively the same as a positive charge being transferred from the acceptor to the donor. The extra electron on the acceptor can then hop to other acceptors and move away from the positively charged donor, resulting in separation of the charges. The separated charges gradually come back together -- some slowly and some more quickly -- and release their energy as light over the span of almost an hour. The mixtures and processes are similar to what are found in organic solar cells and OLEDs. After building up separated charges like in a solar cell, the charges have nowhere to escape, so they eventually comeback together to emit light like an OLED. The key difference in the newly developed mixtures is that the charges can exist in a separated state for very long periods of times.
"With organics, we have a great opportunity to reduce the cost of glow-in-the-dark materials, so the first place we expect to see an impact is large-area applications, such as glowing corridors or roadways for added safety," says Chihaya Adachi, Director of OPERA. "After that, we can start thinking about exploiting the versatility of organic materials to develop glow-in-the-dark fabrics and windows, or even bio-compatible probes for medical imaging." The first challenge to tackle on the road to practical use is the sensitivity of the process to oxygen and water. Protective barriers are already used in organic electronics and inorganic glow-in-the-dark materials, so the researchers are confident that a solution can be found. Concurrently, they are also looking into new molecular structures to increase the emission duration and efficiency as well as to change the colour. With efforts to solve these remaining issues underway, a new wave of glow-in-the-dark materials based on organics look poised to invigorate the area and expand their applications.

Source https://www.sciencedaily.com/releases/2017/10/171002112802.htm

Energy Engineering

9. Bioreactors on A Chip Renew Promises for Algal Biofuels



Colonies of algae inside droplets on a chip. Algal lipids stained red.

For over a decade, companies have promised a future of renewable fuel from algae. Investors interested in moving the world away from fossil fuel have contributed hundreds of millions of dollars to the effort, and with good reason. Algae replicate quickly, requiring little more than water and sunlight to accumulate to massive amounts, which then convert atmospheric CO_2 into lipids (oils) that can be harvested and readily processed into biodiesel. Despite high-profile demonstrations, promises have fallen short, and start-ups have revised business models to include production of specialty lipids, such as those used in cosmetics and soaps. Yet the dream of producing commercial-scale renewable energy persists, as new technologies emerge that might finally lead algal biofuels toward a competitive niche in the marketplace. One of many improvements necessary for sustainable production of algal biofuel is the development of better algae. Recently researchers from Boyce Thompson Institute and Texas A&M University report an exciting new technology that may revolutionize the search for the perfect algal strain: Algal droplet bioreactors on a chip. A single algal cell is captured in a tiny droplet of water encapsulated by oil -- imagine the tiny droplets that form when you mix vegetable oil with water -- then millions of algal droplets squeeze onto a chip about the size of a quarter. Each droplet is a micro-bioreactor, a highly-controlled environment in which algal cells can grow and replicate for several days, forming a genetically homogenous colony that goes through its typical biological reactions, including the production of lipids. "This is the first microsystem that allows both lipid content analysis and growth rate measurement at high throughput, whereas previous work could only do one or the other," remarked senior author and engineer, Arum Han of Texas A&M University. Scientists are racing to identify a super algal strain that can reproduce faster and produce more lipid per cell. With today's gene-editing technologies, modifying algal genes can be relatively straightforward; however, identifying which genes to target is time-consuming and costly. Exposing an algal culture to a mutagen yields millions of unique, potentially improved algal cells that must each be tested for expression of a desired trait, such as increased lipid production. Mutated genes can then be identified through whole-genome sequencing. "The important thing is to develop a tool that can screen millions of cells in a much shorter time frame and a smaller space. In a chip housing millions of droplets of cells, each droplet is like a flask or a bioreactor, and that's how we can get results faster from just a tiny chip," explained author and BTI post-doc, Shih-Chi Hsu.The researchers first validated the chip system with algae known to grow faster or slower, or produce more or less lipid. They then screened 200,000 chemically mutated cells, identifying six mutants with both faster growth and higher lipid content. The screening, done on-chip, uses fluorescence detection of chlorophyll, representing total cell mass, and BODIPY, a fluorescent molecule that binds to lipids. All mutants with potential for improved growth or lipid production were recovered and verified off-chip. While the results of this study are promising, 200,000 is still a low number of mutants compared to what is needed to find that super algal strain. "The most extraordinary variants will be found in one in a million, or ten million, so the throughput needs to be accelerated," explained senior biologist and BTI President, David Stern. Excitingly, the tools for improving throughput are already in development, including larger chips that can screen millions of droplets in one experiment. "Such high-throughput technologies can rapidly accelerate the development process to obtain strains that are more efficient for use in biofuel production," Han remarked. With the discovery and development of much more efficient algal strains, commercial-scale production of biofuel from algae may finally be a realistic promise.

Source https://www.sciencedaily.com/releases/2017/09/170929112954.htm

Interdisciplinary Engineering and Special Fields

10. A Fashionable Chemical and Biological Threat Detector-On-A-Ring

A first-of-its kind ring sensor can detect chemical and biological threats

Wearable sensors are revolutionizing the tech-world, capable of tracking processes in the body, such as heart rates. They're even becoming fashionable, with many of them sporting sleek, stylish designs. But wearable sensors also can have applications in detecting threats that are external to the body. Researchers now report a first-of-its kind device that can do just that. And to stay fashionable, they've designed it as a ring. According to a global analyst firm called CCS Insight, wearable electronics will be a $34 billion industry by 2020. Wearable chemical sensors currently in development include those made in the form of tattoos, mouth guards, wristbands and headbands, but all of these types of sensors face challenges. For example, a sweat sensor worn on an arm could be useful, but patients would need to produce enough sweat for the device to be successful. There is a demand for sensors that are compact, affordable, noninvasive and can be incorporated into everyday life. But more advanced sensors can be costly and difficult to produce. Joseph Wang and colleagues at the University of California, San Diego wanted to develop a portable, affordable, wearable sensor that would detect external chemical threats. The team designed their sensor as a ring that can be worn on a finger. The ring has two parts, an electrochemical sensor cap for detecting chemical and biological threats, and a circuit board under the cap for processing and sending data wirelessly to a smartphone or laptop. It can perform voltammetric and chronoamperometric measurements, which allow the ring to detect a wide array of chemical threats. The team exposed the prototype to explosives and organophosphate nerve agents, both in vapor and liquid phases. The ring was highly selective and sensitive. Although this ring-based sensor was designed to detect explosives and organophosphate nerve agents, the researchers say the device could be expanded to other hazardous environmental or security agents.

Source https://www.sciencedaily.com/releases/2017/10/171011091750.htm

Engineering Innovation in India

This Made-In-IIT Solar Plant Is Illuminating Thousands of Rural Homes in India

You may not be victim to any more power cuts and could even halve your electricity bill, thanks to IIT Madras' new solar rooftop installation. It's both smaller and cheaper than present installations. Priced at Rs 20,000, it can run tubelights, fans, charging points and a TV. If you go for a higher model, it will be able to run all essential load except washing machine and air conditioners. As a part of CSR and government sponsorship, the rooftop plant has been installed in 15,000 rural homes. It was successful in facing a three-day power cut during Chennai floods in December 2015. Now, to install a rooftop of the present technology, a middle-class family would require 1kWh solar rooftop and storage costing about Rs 1.2 lakh and a space of about 100 sq ft. Recently, the solar power system was recognised by The Institute of Electrical and Electronics Engineers (IEEE), New York, as 'Technology of the year 2017 in the service of humanity'. The solar inverterless DC system is cost and energy-efficient as unlike other solar power systems, it does not convert direct current produced by a solar installation into alternate current. The system comes with a full DC wiring. Each time a unit of AC is converted into DC, there is a 15 per cent loss of energy. A DC system is 2.5 times more efficient than the AC system and hence requires lesser space. While a 125W rooftop solar, a 0.5kWh lead acid DC battery, and few DC electrical appliances will cost approximately Rs 20,000, a basic 500W solar power and 3 kWh lead acid storage will cost a bit over Rs 40,000 without taxes. It is believed that a solar-DC microgrid can help break the logjam that the domestic power supply currently faces in India. Even as it's a great start, data with REC shows that about four crore households are yet to be electrified in India.

Source http://www.businessinsider.in/This-made-in-IIT-solar-plant-is-illuminating-thousands-of-rural-homes-in-India/articleshow/58858087.cms