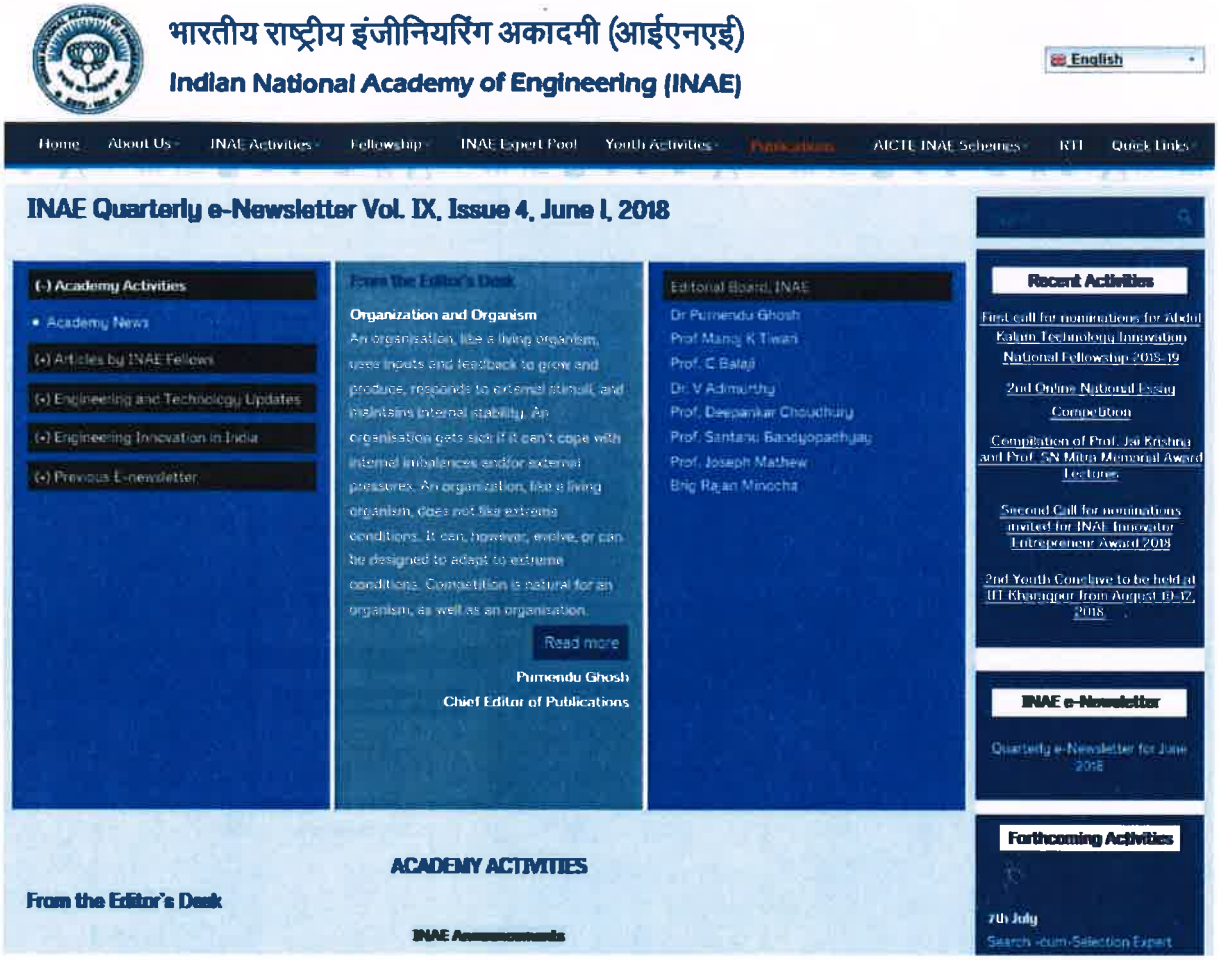
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From the Editor's Desk

Organization and Organism

An organisation, like a living organism, uses inputs and feedback to grow and produce, responds to external stimuli, and maintains internal stability. An organisation gets sick if it can't cope with internal imbalances and/or external pressures. An organization, like a living organism, does not like extreme conditions. It can, however, evolve, or can be designed to adapt to extreme conditions. Competition is natural for an organism, as well as an organisation. Organisations are learning from biology that most severe competitions, and thus most rapid changes, result from environment pressures, and also when the time is too short to respond to those pressures. An organisation which is not under the threat of competition has little chance to evolve. An organisation, like an organism, is selfish as it allows long term changes to occur only if there is reproductive advantage.

Organisations, as well as, organisms are open systems. They influence the environment and are also influenced by the environment. The adaptability of living systems to environmental stress varies from system to system and stress to stress. Beyond a certain threshold point the system may undergo a radical change. Such changes are not necessarily negative. Many systems take advantage of such 'catastrophes' to enhance their overall growth.

Another important question is the degree of complexity an organism or an organisation can withstand. Complexity is observer dependent. What is complex for one observer could be simple for another. It is thus important to recognise the 'relativity of complexity'. The degree of complexity is determined by all the destabilizing or disorganising forces acting on the system. Survival should thus dictate the level of complexity an organism or an organisation can withstand.

If something or someone has outlived its utility, should it be destroyed?

A living being is made up of many atoms and molecules and there is a certain relationship among them. When the desired relationships are broken, life tends to become lifeless. In a living being, cells die by another mechanism. They commit suicide. Some cells die purposefully to ensure proper development of the remaining cells. If these cells remain in the system, the integrity of the organism may get spoiled. It is thus essential to remove them. This pattern of cell death is so orderly that the process is called 'programmed cell death' (PCD). Programmed cell death is important for an organism to be able to eliminate unnecessary or damaged cells from its body. If there was no PCD, we would face 'runaway cell replication'. A somewhat similar thing happens in organisations. New kills an old one. In this age of innovative environment, we are in a hurry to take away resources from the losers and reallocate them to the winners. In this environment, 'outperforming upstarts' are not uncommon, and 'built to last' organisations are becoming a rarity.

Life science tells us that the maturation of the human body, in preparation for reproduction, occurs several years before an age generally considered physically and psychologically appropriate for parenthood. In this there is a message for organisations: capacities to produce (or diversify) and actual production (or diversification) are two different things. Our agility and rapidity decrease after a certain size. It points to the fact that mere growth is not enough. How much one should grow depends on how much one can metabolise. An organisation should know how much it can metabolise.

We know that the continuance is the ultimate goal of an organisation. When we talk of flexibility, adaptability, change, etc., they are meant only to meet this objective. An organisation can remain open, even when a part of it is closed. This is also possible in the case of living beings, but living things being more integrated and complex, the chances of survival of remaining organisms are comparatively less likely.

Continuance is the ultimate goal of both an organisation and an organism. Both need to understand that their right to exist is not perpetual. Both grow when they have the 'will' to grow and survive. Both can sustain only when they begin to see the world beyond their own image. Both are aware of the fact that their growth will eventually stop, if they continue to have confused and impaired vision. Both know their process of death will begin once their sense of the self begins to become meaningless.

Purnendu Ghosh
Chief Editor of Publications

ACADEMY ACTIVITIES

From the Editor's Desk

INAE Announcements

Nominations have been invited for the following:

- **INAE Innovator Entrepreneur Award 2018:** Last Date for receipt of Nominations- **June 30, 2018**
- **Innovative Student Projects Award:** Last Date for receipt of Nominations- **July 7, 2018**

Abdul Kalam Technology Innovation National Fellowship

The first call for nominations for the year 2018-19 was announced on April 24, 2018 for the INAE-SERB, DST Abdul Kalam Technology Innovation National Fellowship, launched in the year 2017; to recognize, encourage and support translational research by Indian Nationals working in various capacities of engineering profession, in **public funded institutions in the country. The last date for the receipt of nominations for first phase of 2018-19 is June 10, 2018.**

The Fellowship is applicable to persons engaged in the engineering profession only. The nominee should have a minimum of 5 years' service left in the parent organization. The Fellowship amount is Rs 25,000/- per month in addition to salary being drawn. A Research Grant of Rs.15.00 lakh per annum, which can be utilized for engineering research and innovation activity including hiring of manpower, consumables, national and international travel for research purposes, chemicals, equipment, etc will also be provided. A maximum of 10 Fellowships will be awarded per year. The duration of the Fellowship will be initially for three years, extendable by upto two more years depending on the performance and the Fellowship can be held for a maximum of 5 years. The guidelines and nomination proforma for the subject Fellowship can be downloaded from INAE website **www.inae.in**

The nomination is valid for one year only and the nominees who had applied earlier during the year 2017-18 are eligible to apply afresh once during the current Financial Year i.e. April 1, 2018 to March 31, 2019. A nominee may apply once in each subsequent Financial Year till he/she has a residual service of five years left in his/her parent organization.

Felicitation of Abdul Kalam Awardees During Technology Day Celebrations on May 11, 2018

The Technology Day was celebrated by Department of Science and Technology (DST), Govt. of India at Vigyan Bhawan, New Delhi on May 11, 2018 and the Function was graced by Hon'ble President of India Shri Ram Nath Kovind and Dr Harsh Vardhan, Minister of Science and Technology. During the function the six Abdul Kalam Awardees selected during the year 2017-18 as per details given below were felicitated by Dr Harsh Vardhan, Minister of Science and Technology.

1) Prof Sirshendu De, Department of Chemical Engineering, Indian Institute of Technology, Kharagpur
2) Prof Krishnan Balasubramanian, Department of Mechanical Engineering, Indian Institute of Technology Madras
3) Prof GK Ananthasuresh, Department of Mechanical Engineering, Indian Institute of Science, Bangalore
4) Prof Navakanta Bhat, Chairperson, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore
5) Dr Sudipta Mukhopadhyay, Associate Professor, Department of Electronics and EC Engineering , Indian Institute of Technology Kharagpur

6) Dr Abhishek, Assistant Professor, Department of Aerospace Engineering, Indian Institute of Technology Kanpur

Hon'ble President of India Shri Ram Nath Kovind, Dr Harsh Vardhan, Minister of Science and Technology and Prof Ashutosh Sharma, Secretary, DST at Vigyan Bhawan, New Delhi with all Awardees

Nominations invited for INAE Innovator Entrepreneur Award 2018

INAE had instituted the Innovator Entrepreneur Award last year with a view to encourage and recognize innovation and entrepreneurship among Young Engineers. Nominations for the subject Award are invited from Fellows/CEOs/Directors/Heads of industry, R&D organizations, Engineering institutions and Departments. The engineering innovations/inventions/concepts that have been actually realized and implemented in industry either in new processes or products would be given weightage. The award carries a **cash prize of Rs 2 lakhs** and the awardee/s would be conferred the same during the Awards Function to be held during the Annual Convention held in December, each year.

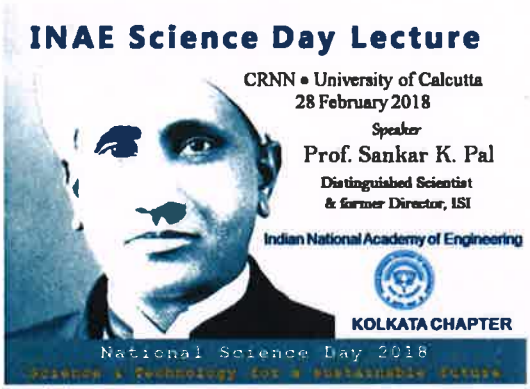
The guidelines along and the application proforma for the subject award can be downloaded from the INAE website www.inae.in. The **last date of receipt of nominations for the current year is June 30, 2018**.

INAE Local Chapters

INAE Kolkata Local Chapter: INAE Science Day Lecture, 28 February 2018.

National Science Day is celebrated in India on 28 February each year to mark the discovery of the Raman effect by the Indian physicist, Sir C. V. Raman. This year's theme was "Science and Technology for a Sustainable Future".

On this occasion, Indian **National Academy of Engineering** (INAE) Kolkata Chapter organized a lecture meeting at the *Centre for Research in Nanoscience and Nanotechnology* (CRNN), University of Calcutta, Salt Lake Campus. Padmashree Prof. Sankar K. Pal, Distinguished Scientist and former Director, Indian Statistical Institute, Kolkata, delivered the lecture to share his experience during his glorious journey over the last 40+ years in the field of Data Science and Machine Intelligence. Prof. Bhargab B. Bhattacharya, President, INAE Kolkata Chapter, presided over the function and discussed the scope and opportunities of various schemes and programs offered by the INAE. Prof. Debatosh Guha, Director, CRNN, Calcutta University, and Secretary, INAE Kolkata Chapter, highlighted the recent activities of the INAE, and addressed the possibilities for the students and faculty members to be associated with the Academy and encouraged them to publish their scientific works in INAE Letters. It was a successful and motivating event attended by more than 60 participants including INAE Fellows, researchers, students, and faculty members from various institutes, Universities, and industries in and around Kolkata.



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Prof. Sankar K. Pal delivering INAE Science Day Lecture at Kolkata


A part of the audience present in INAE Science Day Program at Kolkata

INAE Pune Local Chapter

A meeting of the INAE Fellows based at Pune was held on April 21, 2018 at Thermax House, Pune which was attended by about fifteen INAE Fellows, wherein it was decided to launch the INAE Local Chapter at Pune. During the meeting, the Fellows interacted and shared valuable inputs for undertaking various activities. The names of Mr. MV Kotwal as the Chairman and Prof. Vinay Kulkarni as the Honorary Secretary of the Pune Local Chapter were unanimously proposed. It was suggested that the Pune Engineering Forum be formed under the aegis of the INAE Pune Local Chapter to induct non-Fellows as members, so as to also involve them in the conduct of various activities to be undertaken. An interactive Technical Session on "Technology Imperatives for India in the next decade" was organized by Dr. RR Sonde, FNAE and Executive Vice-President, Thermax. This was followed by a technical visit to the R&D facility and Coal Gasifiers developed by Thermax.

Activities Undertaken by INAE Sectional Committees

The Activities Undertaken by the **INAE Sectional Committee-V (Electrical Engineering)** during the Year 2017 are highlighted below. The Committee has been working towards achieving the goals mentioned below.

1. **Increasing Visibility of Sectional Committee as well as INAE**

   The Sectional Committee took special drive in this context and has launched its dedicated website which can be viewed at the link http://www.inaesection5.org.in/. The website highlights: i) Activities of Sectional Committee – V and ii) Brings INAE Sec-V Fellows in the forefront.

2. **Engaging Sec-V Fellows of INAE**

   With the above goal in mind, 'Fellows Corner' is being created in the website. In this online forum, Sec-V Fellows are invited to write small articles expressing their views on topics of their choice.

3. **Distinctive Voices**

   The Sectional Committee is inviting leaders in Electrical Engineering in Knowledge Sharing through this online section of its website.

4. **Bringing in Achievers in the Field of Electrical Engineering in the fold of INAE**

   The Sectional committee is working

   - proactively to search for outstanding persons from academia and industry for nomination as INAE fellows (Indian as well as Foreign Fellows).
   - to organize focused programs wherein researchers can come and exchange views.

5. **Promoting Engineering Excellence among Young Engineers and Students**

   The Sectional Committee-V is engaged in efforts to achieve the following:

   - Promoting outstanding young engineers in the field of electrical engineering through nomination for young engineer award.
   - Bringing in more and more excellent electrical engineering students through nomination for best student project awards.

INAE on Facebook and Twitter

INAE has created a Facebook and twitter Account to post the news of recent INAE activities in the Social Media. The same can be viewed at the link below.

(a) Facebook -link https://www.facebook.com/pages/Indian-National-Academy-of-Engineering/714509531987607?ref=hl

(b) Twitter handle link https://twitter.com/inaehq1

All INAE Fellows are requested to visit and follow the above to increase the visibility of INAE in Social media.

Important Meetings held during March, April and May 2018

- **Second Meeting of the Search-cum-Selection Committee for Abdul Kalam National Innovation Fellowship held on March 10, 2018 at INAE Office, Gurgaon**
- **Meeting with CEO, Niti Aayog held on March 14, 2018 at Niti Aayog, New Delhi**
- **INAE Governing Council Meeting held on Mar 16, 2018 at Kolkata**

- **Meeting of Dr BN Suresh, President, INAE with PSA, Govt. of India held on April 27, 2018 at Vigyan Bhawan Annexe, New Delhi**
- **INAE Apex Committee Meeting held on April 27, 2018 at INAE Office, Gurgaon**
- **INAE-DST Consultative Committee Meeting held on April 27, 2018 at DST**
- **First meeting of Sectional Committees for shortlisting of nominations for Election of Fellows, Foreign Fellows and Young Engineer Award held Between 1st to 11th May 2018 at INAE Office, Gurgaon**
- **Meeting of INAE Forum on "Civil Infrastructure held on May 1, 2018 at DKRC, New Delhi**

Academia Industry Interaction

AICTE-INAE Distinguished Visiting Professorship Scheme

Industry-academia interactions over technological changes have become essential in recent times so that relevant knowledge that would be sustainable in the changing conditions can be imparted to the students in the engineering institutions. While industries could gain by using the academia's knowledge base to improve the industry's cost, quality and global competitive dimensions; thereby reducing dependence on foreign know-how and expenditure on internal R&D, academics benefit by seeing their knowledge and expertise being fruitfully utilized practically and also by strengthening of curricula of educational programs being offered at engineering colleges/institutions. INAE together with All India Council for Technical Education (AICTE) launched "AICTE-INAE Distinguished Visiting Professorship Scheme" in 1999. Under this scheme, Industry experts are encouraged to give a few lectures in engineering institutions. This scheme has become popular among industry experts as well as engineering colleges.

Brief details pertaining to recent visits of industry experts under this scheme are given below.

Dr. Vithal Narasinha Kamat Managing Director, Baroda Electric Meters Ltd.	Sarvajanik College of Engineering and Technology, Surat Jan 23, 2018 Feb 27, 2018	Delivered lecture on "Introduction to Machine Learning". Delivered lecture on "Unlocking your Employability". As per the feedback from the Faculty Coordinator of the engineering college, the interaction of the Industry Expert with students and faculty members has been beneficial as he suggested problem statements and practical application of the theoretical knowledge.
Dr Chaitanyamoy Ganguly Retired Distinguished Scientist, DAE	School of Nuclear Studies and Applications, Jadavpur University, Kolkata April 12-13, 2018 School of Nuclear Studies	Delivered lectures on "Front End of Uranium Fuel Cycle" and "Back End of Uranium Fuel Cycle". Delivered lectures on "Operating Gen II &

	and Applications, Jadavpur University, Kolkata Jan 15-16, 2018	Gen III Nuclear Power Reactors and their Fuel Cycle Technology" and "Generation IV and Small Modular Reactor Systems and "Closed" Nuclear Fuel Cycle with Partitioning & Transmutation". As per the feedback from the engineering college the Visiting Professor should be encouraged to provide research guidance through visits of longer duration.
Dr Manish Roy Scientist 'F', Defence Metallurgical Research Laboratory, Kanchanbagh	Department of Metallurgical Engineering, JNTUH, Hyderabad April 26, 2018 Indian Institute of Engineering Science and Technology, Shibpur April 18-19, 2018	Delivered lecture on "Physical Vapour Deposition". Also identified a project titled "Erosion of Abradable Coatings". As per the feedback from engineering college, the scheme provides an excellent opportunity for purposeful interaction between industry and academicians. Delivered lectures on "Physical Vapour Deposition" and "Diffusion Coatings". As per the feedback from the Faculty Coordinator, this scheme helps provide many new and pragmatic ideas which can be translated into actions.
Dr Jayanta Kumar Saha Deputy General Manager (Applications) Institute for Steel Development & Growth	Indian Institute of Engineering Sciences and Technology, Shibpur Mar 9 & Mar 27, 2018 Jadavpur University, Kolkata Mar 20 & 22, 2018 Indian Institute of Engineering Sciences and Technology, Shibpur Jan 29 & Feb 2, 2018	Delivered lectures on "Usage of Structural Steel for Construction" and "Practical Ways to Control Corrosion of Steel". As per the feedback from Engineering College, the lectures delivered by the Visiting Professor helps students to correlate application aspects with theoretical knowledge. Delivered lectures on "Steel Product Portfolio and Auto Grade Steel Including Trends & Technology"; "Different Types of Corrosion Prevention of Steel Structures wrt Codes & Standards" and "An Exposure to Joining Techniques". As per the feedback from the engineering college this kind of academia -industry interaction is very useful for students as they get a feel of actual industrial practices. Delivered Lectures on "Need for Applied Knowledge in Metallurgical Engineering" and "Latest Steel Making Technology and Alternate Steel Making". As per the feedback from Engineering College, the Visiting Professor guided projects and suggested changes in curriculum. The interactive sessions helped the students to correlate the applications with theoretical knowledge. The Visiting Professor is also

	Jadavpur University, Kolkata Feb 6 & 15, 2018	helping students in skill development. Delivered lectures "Overview of Iron & Steel Making and its Generic Usage in Engineering Application" and "Latest Trends in Steel Products: Both Structural and Automotive Grade wrt Innovation & Technology". As per the feedback from Engineering College, the lectures by the Industry expert helped students correlate applications with theoretical knowledge.
Mr. Kezar Ali Shah General Manager(Environment) Wonder Cement Ltd	College of Technology & Engineering, Maharana Pratap University of Agriculture & Technology, Udaipur Mar 23, 2018	Delivered lecture on "Environment Clearance of Construction Projects".
Dr. Suvankar Ganguly Principal Scientist, R&D Division, TATA Steel Ltd.	Department of Mechanical Engineering, Jadavpur University April 5, 2018	Delivered lecture on "Application of Computational Fluid Dynamics (CFD) to Industrial Process Modelling: Examples of Steel Making and Casting". Also identified project on Heat Transfer in Casting /Hot Rolling. As per the feedback from engineering college, the interaction with the industry expert helps highlight the relevance of fundamental aspects taught in classrooms and their application to industrial practices. This motivates both the students and faculty members.

International Conferences/Seminars being organized by IITs/other Institutions

To view a list of International Conferences/Seminars being held in the month of June, July and August 2018 click here.

Honours and Awards

1.	Prof MR Madhav, FNAE, Professor Emeritus, JNT University and Visiting Professor, IIT Hyderabad was felicitated with a Special Issue of Geotechnical Engineering Journal of the SEAGS & AGSSEA, Vol 49, No.1, March 2018 brought out in his honour in recognition of his contributions in Geotechnics through Indian Geotechnical society, ISSMGE and in IIT Kanpur etc.
2	Dr. S. Venkata Mohan FNAE, Principal Scientist, Bioengineering and Environmental Sciences Lab, CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad was conferred the "Environmental Engineering Design Award 2017" by the National Design and Research Forum (NDRF), Institute of Engineers, India (IEI) for the outstanding contributions in the field of Engineering Design (Dec 2017) at Chennai during the Annual Convention of IEI.

News of Fellows

1.	Prof S. C. Dutta Roy, FNAE, formerly Professor of Electrical Engineering, Indian Institute of Technology Delhi has authored a book on "Circuits, Systems and Signal Processing", which has been published by Springer recently. This book is a collection of tutorial-like chapters on all core topics of signals and systems and the electronic circuits. All the topics dealt with in book are parts of the core syllabi of standard programs in Electrical Engineering, Electrical and Computer Engineering, and Electronics and Telecommunication Engineering domains.
2	Dr. R.A. Mashelkar, FRS, FNAE National Research Professor and President, Global Research Alliance, Pune delivered the 20th K.R. Narayanan Memorial Oration on April 19, 2018 at Australian National University, Canberra, Australia on the topic "Dismantling Inequalities Through Assured Innovation". Hon'ble President of India Shri Ram Nath Kovind graciously sent an inspiring message on the occasion.

International Conferences in June, July and August 2018

International Conference on Recent Research in Computer Science and Information Technology (CSIT– 2018) on June 2, 2018 at New Delhi,
https://conferencealerts.com/show-event?id=199881

International Conference on Recent Advances in Electrical Electronic Communication & Industrial Engineering (EIT –2018) on June 2, 2018 at New Delhi
https://conferencealerts.com/show-event?id=199882

9th ICCCNT IEEE Conference 2018 on July 10-12, 2018 at Bengaluru, Karanataka
https://conferencealerts.com/show-event?id=196798

Second International Conference on Recent Research Emerging Trends in Mechanical and Civil Engineering (ICRRTMCE-2018) on July 13-14, 2018 at Bangalore, Karnataka
https://conferencealerts.com/show-event?id=199010

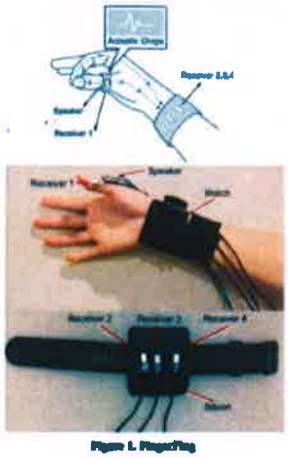
Civil Engineering

1. Scientists Create Innovative New 'Green' Concrete Using Graphene

A new greener, stronger and more durable concrete that is made using the wonder-material graphene could revolutionise the construction industry. Experts from the University of Exeter have developed a pioneering new technique that uses nanoengineering technology to incorporate graphene into traditional concrete production. The new composite material, which is more than twice as strong and four times more water resistant than existing concretes, can be used directly by the construction industry on building sites. Crucially, the new graphene-reinforced concentre material also drastically reduced the carbon footprint of conventional concrete production methods, making it more sustainable and environmentally friendly. The research team insist the new technique could pave the way for other nanomaterials to be incorporated into concrete, and so further modernise the construction industry worldwide. This new composite material is an absolute game-changer in terms of reinforcing traditional concrete to meets the needs of cities. Not only is it stronger and more durable, but it is also more resistant to water, making it uniquely suitable for construction in areas which require maintenance work and are difficult to be accessed. Yet perhaps more importantly, by including graphene we can reduce the amount of materials required to make concrete by around 50 per cent -- leading to a significant reduction of 446kg/tonne of the carbon emissions. This unprecedented range of functionalities and properties uncovered are an important step in encouraging a more sustainable, environmentally-friendly construction industry worldwide. Previous work on using nanotechnology has concentrated on modifying existing components of cement, one of the main elements of concrete production. In the innovative new study, the research team has created a new technique that centres on suspending atomically thin graphene in water with high yield and no defects, low cost and compatible with modern, large scale manufacturing requirements. Dimitar Dimov, the lead researcher from the University of Exeter added: "This ground-breaking research is important as it can be applied to large-scale manufacturing and construction. The industry has to be modernised by incorporating not only off-site manufacturing, but innovative new materials as well. "Finding greener ways to build is a crucial step forward in reducing carbon emissions around the world and so help protect our environment as much as possible. It is the first step, but a crucial step in the right direction to make a more sustainable construction industry for the future."

Source https://www.sciencedaily.com/releases/2018/04/180423110721.htm

2. Wearable Ring, Wristband Allow Users to Control Smart Tech with Hand Gestures



The FingerPing system can recognize hand poses using the 12 bones of the fingers and digits '1' through '10' in American Sign Language (ASL).

New technology created by a team of Georgia Tech researchers could make controlling text or other mobile applications as simple as "1-2-3." Using acoustic chirps emitted from a ring and received by a wristband, like a smartwatch, the system is able to recognize 22 different micro finger gestures that could be programmed to various commands -- including a T9 keyboard interface, a set of numbers, or application commands like playing or stopping music. A video demonstration of the technology shows how, at a high rate of accuracy, the system can recognize hand poses using the 12 bones of the fingers and digits '1' through '10' in American Sign Language (ASL). "Some interaction is not socially appropriate," said Cheng Zhang, a researcher in the School of Interactive Computing who led the effort. "A wearable is always on you, so you should have the ability to interact through that wearable at any time in an appropriate and discreet fashion. When we're talking, I can still make some quick reply that doesn't interrupt our interaction." The system is also a preliminary step to being able to recognize ASL as a translator in the future, Zhang said. Other techniques utilize cameras to recognize sign language, but that can be obtrusive and is unlikely to be carried everywhere. "If my wearable can translate it for me, that's the long-term goal," Zhang said. The system is called FingerPing. Unlike other technology that requires the use of a glove or a more obtrusive wearable, this technique is limited to just a thumb ring and a watch. The ring produces acoustic chirps that travel through the hand and are picked up by receivers on the watch. There are specific patterns in which sound waves travel through structures, including the hand, that can be altered by the manner in which the hand is posed. Utilizing those poses, the wearer can achieve up to 22 pre-programmed commands. The gestures are small and non-invasive, as simple as tapping the tip of a finger or posing your hand in classic "1," "2," and "3" gestures. "The receiver recognizes these tiny differences," Zhang said. "The injected sound from the thumb will travel at different paths inside the body with different hand postures. For instance, when your hand is open there is only one direct path from the thumb to the wrist. Any time you do a gesture where you close a loop, the sound will take a different path and that will form a unique signature." Zhang said that the research is a proof of concept for a technique that could be expanded and improved upon in the future.

Source https://www.sciencedaily.com/releases/2018/05/180514151908.htm

3. Cheap 3-D Printer Can Produce Self-Folding Materials

CMU process takes advantage of a common printing defect

A computer-controlled process developed at Carnegie Mellon University enables flat pieces of plastic produced in an inexpensive 3-D printer to assume predetermined 3-D shapes when heated.

Researchers at Carnegie Mellon University have used an inexpensive 3-D printer to produce flat plastic items that, when heated, fold themselves into predetermined shapes, such as a rose, a boat or even a bunny. Lining Yao, assistant professor in the Human-Computer Interaction Institute and director of the Morphing Matter Lab, said these self-folding plastic objects represent a first step toward products such as flat-pack furniture that assume their final shapes with the help of a heat gun. Emergency shelters also might be shipped flat and fold into shape under the warmth of the sun. Self-folding materials are quicker and cheaper to produce than solid 3-D objects, making it possible to replace noncritical parts or produce prototypes using structures that approximate the solid objects. Moulds for boat hulls and other fibreglass products might be inexpensively produced using these materials. Other researchers have explored self-folding materials, but typically have used exotic materials or depended on sophisticated processing techniques not widely available. Yao and her research team were able to create self-folding structure by using the least expensive type of 3-D printer -- an FDM printer -- and by taking advantage of warpage, a common problem with these printers. "We wanted to see how self-assembly could be made more democratic -- accessible to many users," Yao said. FDM printers work by laying down a continuous filament of melted thermoplastic. These materials contain residual stress and, as the material cools and the stress is relieved, the thermoplastic tends to contract. This can result in warped edges and surfaces. "People hate warpage," Yao said. "But we've taken this disadvantage and turned it to our advantage." To create self-folding objects, she and her team precisely control this process by varying the speed at which thermoplastic material is deposited and by combining warp-prone materials with rubber-like materials that resist contracture. The objects emerge from the 3-D printer as flat, hard plastic. When the plastic is placed in water hot enough to turn it soft and rubbery -- but not hot enough to melt it -- the folding process is triggered. Though they used a 3-D printer with standard hardware, the researchers replaced the machine's open source software with their own code that automatically calculates the print speed and patterns necessary to achieve particular folding angles. "The software is based on new curve-folding theory representing banding motions of curved area. The software based on this theory can compile any arbitrary 3-D mesh shape to an associated thermoplastic sheet in a few seconds without human intervention," said Byoungkwon An, a research affiliate in HCII. "It's hard to imagine this being done manually," Yao said. Though these early examples are at a desktop scale, making larger self-folding objects appears feasible. "We believe the general algorithm and existing material systems should enable us to eventually make large, strong self-folding objects, such as chairs, boats or even satellites," said Jianzhe Gu, HCII research intern.

Source https://www.sciencedaily.com/releases/2018/04/180424112836.htm

4. New Catalyst Upgrades Greenhouse Gas into Renewable Hydrocarbons

Engineering team designs most efficient and stable process for converting climate-warming carbon dioxide into a key chemical building block

Researchers demonstrate their new catalyst. The team demonstrated most efficient and stable process for converting climate-warming carbon dioxide into the building blocks for plastics, all powered using renewable electricity.

A new technology from U of T Engineering is taking a substantial step towards enabling manufacturers to create plastics out of two key ingredients: sunshine and pollution. Today, non-renewable fossil fuels not only provide the raw material from which plastics are made, they are also the fuel burned to power the manufacturing process, producing climate-warming carbon dioxide (CO_2) -- the International Energy Agency estimates the production of the main precursors for plastics is responsible for 1.4 per cent of global CO_2 emissions. A team led by University of Toronto Professor Ted Sargent is turning this process on its head. They envision capturing CO_2produced by other industrial process and using renewable electricity -- such as solar power -- to transform it into ethylene. Ethylene is a common industrial chemical that is a precursor to many plastics, such as those used in grocery bags. The system addresses a key challenge associated with carbon capture. While technology exists to filter and extract CO_2 from flue gases, the substance currently has little economic value that can offset the cost of capturing it -- it's a money-losing proposition. By transforming this carbon into a commercially valuable product like ethylene, the team aims to increase the incentives for companies to invest in carbon capture technology. At the core of the team's solution are two innovations: using a counterintuitively thin copper-based catalyst and a reimagined experimental strategy. "When we performed the CO_2 conversion to ethylene in very basic media, we found that our catalyst improved both the energy efficiency and selectivity of the conversion to the highest levels ever recorded," said post-doctoral fellow Dr. Cao-Thang Dinh, a researcher. In this context, efficiency means that less electricity is required to accomplish the conversion. The researchers then used this knowledge to further improve the catalyst and push the reaction to favour the formation of ethylene, as opposed to other substances. Next, the team addressed stability, which has long been a challenge with this type of copper-based catalyst. Theoretical modelling shows that basic conditions -- that is, high pH levels -- are ideal for catalyzing CO_2 to ethylene. But under these conditions, most catalysts, and their supports, break down after less than 10 hours. The team overcame this challenge by altering their experimental setup. Essentially, they deposited their catalyst on a porous support layer made of polytetrafluoroethylene (PTFE, better known as Teflon) and sandwiched their catalyst with carbon on the other side. This new setup protects the support and catalyst from degrading due to the basic solution, and enables it to last 15 times longer than previous catalysts. As an added bonus, this setup also improved efficiency and selectivity still further. "Over the last few decades, we've known that operating this reaction under basic conditions would help, but no one knew how to take advantage of that knowledge and transfer it into a practical system," says Dinh. "We've shown how to overcome that challenge." Currently their system is capable of performing the conversion on a laboratory scale, producing several grams of ethylene at a time. The team's long-term goal is to scale the technology up to the point where they are able to convert the multiple tonnes of chemicals needed for commercial application. "We made three simultaneous advances in this work: selectivity, energy-efficiency and stability," says a researcher. "As a group, we are strongly motivated to develop technologies that help us realize the global challenge of a carbon-neutral future."

Source https://www.sciencedaily.com/releases/2018/05/180517143614.htm

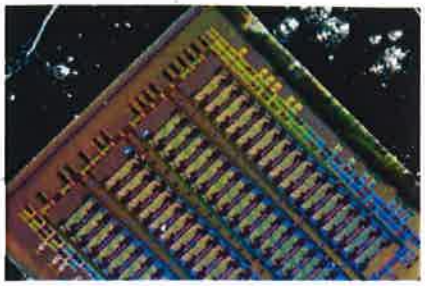
5. Engineers Invent Smart Microchip That Can Self-Start and Operate When Battery Runs Out

Game-changing technology maximizes lifetime and enables smaller, cheaper IoT devices. The Internet of Things (IoT), while still in its infancy, is shaping the future of many industries and will also impact our daily lives in significant ways. One of the key challenges of moving IoT devices from concept to reality is to have long-lasting operation under tightly constrained energy sources, thus demanding extreme power efficiency. IoT devices -- such as sensors -- are often deployed on a massive scale and in places that are usually remote and difficult to service regularly, thus making their self-sufficiency essential. Currently, batteries in IoT devices are much larger and up to three times more expensive than the single chip they power. Their size is determined by the sensor node lifetime, which directly affects how often they need to be changed. This has an important bearing on maintenance cost and impact on the environment when batteries are disposed. To extend the overall lifetime, the battery is usually recharged slowly by harvesting some limited power from the environment, such as using a solar cell. However, existing IoT devices cannot operate without battery, and small batteries are fully discharged more frequently. Hence, battery miniaturisation often results in highly discontinuous operation of IoT devices, as they stop functioning every time the battery runs out of energy. To address this technology gap, a team of engineers from the National University of Singapore (NUS) has developed an innovative microchip, named BATLESS, that can continue to operate even when the battery runs out of energy. BATLESS is designed with a novel power management technique that allows it to self-start and continue to function under dim light without any battery assistance, using a very small on-chip solar cell. This research breakthrough substantially reduces the size of batteries required to power IoT sensor nodes, making them 10 times smaller and cheaper to produce. The leader of the NUS research team, Associate Professor Massimo Alioto from the Department of Electrical and Computer Engineering at the NUS Faculty of Engineering, said "We have demonstrated that batteries used for IoT devices can be shrunk substantially, as they do not always need to be available to maintain continuous operation. Tackling this fundamental problem is a major advancement towards the ultimate vision of IoT sensor nodes without the use of batteries, and will pave the way for a world with a trillion IoT devices." Battery indifference is the ability for IoT devices to continue operations, even when the battery is exhausted. It is achieved by operating in two different modes -- minimum-energy and minimum-power. When the battery energy is available, the chip runs in minimum-energy mode to maximise the battery lifetime. However, when the battery is exhausted, the chip switches to the minimum-power mode and operates with a tiny power consumption of about half a nanoWatt -- this is about a billion times smaller than the power consumption of a smartphone during a phone call. Power can be provided by a very small on-chip solar cell that is about half a square millimetre in area, or other forms of energy available from the environment, such as vibration or heat. The chip's ability to switch between minimum energy and minimum power mode translates into aggressive miniaturisation of batteries from centimetres down to a few millimetres. The BATLESS microchip enables the uncommon capability to uninterruptedly sense, process, capture and timestamp events of interest, and for such valuable data to be wirelessly transmitted to the cloud when the battery becomes available again. Despite being in minimum-power mode when battery is not available, the reduced speed of the microchip is still adequate for numerous IoT applications that need to sense parameters that vary slowly in time, including temperature, humidity, light, and pressure. Among many other applications, BATLESS is very well suited for smart buildings, environmental monitoring, energy management, and adaptation of living spaces to occupants' needs. Assoc Prof Alioto added, "BATLESS is the first example of a new class of chips that are indifferent to battery charge availability. In minimum-power mode, it uses 1,000 to 100,000 times less power, compared to the best existing microcontrollers designed for fixed minimum-energy operation. At the same time, our 16-bit microcontroller can also operate 100,000 times faster than others that have been recently designed for fixed minimum-power operation. In short, the BATLESS microchip covers a very wide range of possible energy, power, and speed trade-offs, as allowed by the flexibility offered through the two different modes." BATLESS is also equipped with a new power management technique that enables operations to be self-started, while being powered directly by the tiny on-chip solar cell, with no battery assistance. The team had demonstrated this at 50-lux indoor light intensity, which is equivalent to the dim light available at twilight, and corresponds to nanoWatts of power. This makes BATLESS indifferent to battery availability, addressing a previously unsolved challenge in battery-less chips.

Source https://www.sciencedaily.com/releases/2018/05/180503101739.htm

6. Path to a New Era of Microelectronics

New manufacturing process will enable photonic communication in consumer devices



Photograph of the bulk silicon electronic-photonic chip designed by the MIT, UC Berkeley and Boston University team

A new microchip technology capable of optically transferring data could solve a severe bottleneck in current devices by speeding data transfer and reducing energy consumption by orders of magnitude. Researchers from Boston University, Massachusetts Institute of Technology, the University of California Berkeley and University of Colorado Boulder have developed a method to fabricate silicon chips that can communicate with light and are no more expensive than current chip technology. The electrical signaling bottleneck between current microelectronic chips has left light communication as one of the only options left for further technological progress. The traditional method of data transfer-electrical wires-has a limit on how fast and how far it can transfer data. It also uses a lot of power and generates heat. With the relentless demand for higher performance and lower power in electronics, these limits have been reached. But with this new development, that bottleneck can be solved. "Instead of a single wire carrying 10 to 100 gigabits per second, you can have a single optical fibre carrying 10 to 20 terabits per second -- so about a thousand times more in the same footprint," says a lead researcher. "If you replace a wire with an optical fibre, there are two ways you win," he says. "First, with light, you can send data at much higher frequencies without significant loss of energy as there is with copper wiring. Second, with optics, you can use many different colours of light in one fibre and each one can carry a data channel. The fibres can also be packed more closely together than copper wires can without crosstalk." In the past, progress to integrate a photonic capability onto state-of-the-art chips that are used in computers and smartphones was hindered by a manufacturing roadblock. Modern processors are enabled by highly developed industrial semiconductor manufacturing processes capable of stamping out a billion transistors that work together on one chip. But these manufacturing processes are finely tuned and designing an approach to include optical devices on chips while keeping the current electrical capabilities intact proved difficult. The first major success in overcoming this roadblock was in 2015 when the same group of researchers solved this problem, but did so in a limited commercially relevant setting. The research demonstrated the world's first microprocessor with a photonic data transfer capability and the approach to manufacturing it without changing the original manufacturing process-a concept the researchers have termed a zero-change technology. However, this previous approach was applicable to a small fraction of state-of-the-art microelectronic chips that did not include the most prevalent kind, which use a starting material referred to as bulk silicon. In the new work, the researchers present a manufacturing solution applicable to even the most commercially widespread chips based on bulk silicon, by introducing a set of new material layers in the photonic processing portion of the silicon chip. They demonstrate that this change allows optical communication with no negative impact on electronics. By working with state-of-the-art semiconductor manufacturing researchers at CNSE Albany to develop this solution, the scientists ensured that any process that was developed could be seamlessly inserted into current industry-level manufacturing. "By carefully investigating and optimizing the properties of the additional material layers for photonic devices, we managed to demonstrate state-of-the-art system-level performance in terms of bandwidth density and energy consumption while starting from a much less expensive process compared to competing technologies," says a researcher. The new platform, which brings photonics to state-of-the-art bulk silicon microelectronic chips, promises faster and more energy efficient communication that could vastly improve computing and mobile devices. Applications beyond traditional data communication include accelerating the training of deep-learning artificial neural networks used in image and speech recognition tasks, and low-cost infrared LIDAR sensors for self-driving cars, smartphone face identification and augmented reality technology. In addition, optically enabled microchips could enable new types of data security and hardware authentication, more powerful chips for mobile devices operating on 5th generation (5G) wireless networks, and components for quantum information processing and computing.

Source https://www.sciencedaily.com/releases/2018/04/180420170551.htm

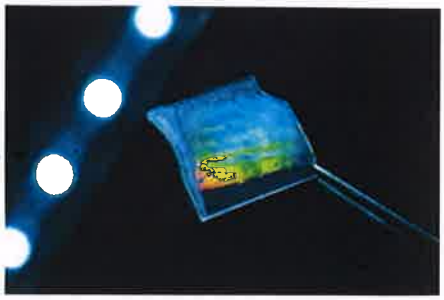
7. Virtual-Reality Testing Ground for Drones: With New System, Drones Navigate Through an Empty Room, Avoiding Crashes While 'Seeing' a Virtual World

MIT engineers have developed a new virtual-reality training system for drones that enables a vehicle to "see" a rich, virtual environment while flying in an empty physical space.

Training drones to fly fast, around even the simplest obstacles, is a crash-prone exercise that can have engineers repairing or replacing vehicles with frustrating regularity. Now MIT engineers have developed a new virtual-reality training system for drones that enables a vehicle to "see" a rich, virtual environment while flying in an empty physical space. The system, which the team has dubbed "Flight Goggles," could significantly reduce the number of crashes that drones experience in actual training sessions. It can also serve as a virtual testbed for any number of environments and conditions in which researchers might want to train fast-flying drones. The lead researcher was initially motivated by a new, extreme robo-sport: competitive drone racing, in which remote-controlled drones, driven by human players, attempt to out-fly each other through an intricate maze of windows, doors, and other obstacles. He wondered: Could an autonomous drone be trained to fly just as fast, if not faster, than these human-controlled vehicles, with even better precision and control? Currently, training autonomous drones is a physical task: Researchers fly drones in large, enclosed testing grounds, in which they often hang large nets to catch any careening vehicles. They also set up props, such as windows and doors, through which a drone can learn to fly. When vehicles crash, they must be repaired or replaced, which delays development and adds to a project's cost. The researcher Karaman says testing drones in this way can work for vehicles that are not meant to fly fast, such as drones that are programmed to slowly map their surroundings. But for fast-flying vehicles that need to process visual information quickly as they fly through an environment, a new training system is necessary. The team's new virtual training system comprises a motion capture system, an image rendering program, and electronics that enable the team to quickly process images and transmit them to the drone. The actual test space -- a hangar-like gymnasium in MIT's new drone-testing facility in Building 31 -- is lined with motion-capture cameras that track the orientation of the drone as it's flying. With the image-rendering system, Karaman and his colleagues can draw up photorealistic scenes, such as a loft apartment or a living room, and beam these virtual images to the drone as it's flying through the empty facility. The virtual images can be processed by the drone at a rate of about 90 frames per second -- around three times as fast as the human eye can see and process images. To enable this, the team custom-built circuit boards that integrate a powerful embedded supercomputer, along with an inertial measurement unit and a camera. They fit all this hardware into a small, 3-D-printed nylon and carbon-fiber-reinforced drone frame. The researchers carried out a set of experiments, including one in which the drone learned to fly through a virtual window about twice its size. The window was set within a virtual living room. As the drone flew in the actual, empty testing facility, the researchers beamed images of the living room scene, from the drone's perspective, back to the vehicle. As the drone flew through this virtual room, the researchers tuned a navigation algorithm, enabling the drone to learn on the fly. Over 10 flights, the drone, flying at around 2.3 meters per second, successfully flew through the virtual window 361 times, only "crashing" into the window three times, according to positioning information provided by the facility's motion-capture cameras. Karaman points out that, even if the drone crashed thousands of times, it wouldn't make much of an impact on the cost or time of development, as it's crashing in a virtual environment and not making any physical contact with the real world. In a final test, the team set up an actual window in the test facility, and turned on the drone's onboard camera to enable it to see and process its actual surroundings. Using the navigation algorithm that the researchers tuned in the virtual system, the drone, over eight flights, was able to fly through the real window 119 times, only crashing or requiring human intervention six times.

Source https://www.sciencedaily.com/releases/2018/05/180517142537.htm

8. Materials Scientists Develop New Forming Technology: Processing Glass like a Polymer

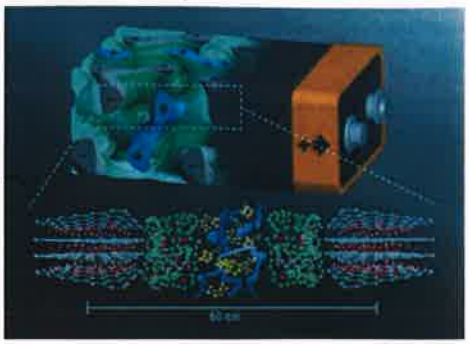


This is an image of glassomer. Glassomer can be milled, turnered, lasered or processed in CNC machines - just like a conventional polymer.

Pure quartz glass is highly transparent and resistant to thermal, physical, and chemical impacts. These are optimum prerequisites for use in optics, data technology or medical engineering. For efficient, high-quality machining, however, adequate processes are lacking. Scientists of Karlsruhe Institute of Technology (KIT) have developed a forming technology to structure quartz glass like a polymer. "It has always been a big challenge to combine highly pure quartz glass and its excellent properties with a simple structuring technology," says Dr. Bastian E. Rapp, Head of the NeptunLab interdisciplinary research group of KIT's Institute of Microstructure Technology (IMT). Rapp and his team develop new processes for industrial glass processing. "Instead of heating glass up to 800 °C for forming or structuring parts of glass blocks by laser processing or etching, we start with the smallest glass particles," says the mechanical engineer. The scientists mix glass particles of 40 nanometers in size with a liquid polymer, form the mix like a sponge cake, and harden it to a solid by heating or light exposure. The resulting solid consists of glass particles in a matrix at a ratio of 60 to 40 vol%. The polymers act like a bonding agent that retains the glass particles at the right locations and, hence, maintains the shape. This "Glassomer" can be milled, turned, laser-machined or processed in CNC machines just like a conventional polymer. "The entire range of polymer forming technologies is now opened for glass," Rapp emphasizes. For fabricating high-performance lenses that are used in smartphones among others, the scientists produce a Glassomer rod, from which the lenses are cut. For highly pure quartz glass, the polymers in the composite have to be removed. For doing so, the lenses are heated in a furnace at 500 to 600 °C and the polymer is burned fully to CO_2. To close the resulting gaps in the material, the lenses are sintered at 1300 °C. During this process, the remaining glass particles are densified to pore-free glass. This forming technology enables production of highly pure glass materials for any applications, for which only polymers have been suited so far. This opens up new opportunities for the glass processing industry as well as for the optical industry, microelectronics, biotechnology, and medical engineering. "Our process is suited for mass production. Production and use of quartz glass are much cheaper, more sustainable, and more energy-efficient than those of a special polymer," Rapp explains. This is the third innovation for the processing of quartz glass that has been developed by NeptunLab on the basis of a liquid glass-polymer mixture. In 2016, the scientists already succeeded in using this mixture for moulding. In 2017, they applied the mixture for 3D printing and demonstrate its suitability for additive manufacture.

Source https://www.sciencedaily.com/releases/2018/05/180517102350.htm

9. Self-Assembling 3D Battery Would Charge in Seconds



A rendering of the 3D battery architecture with interpenetrating anode (grey, with minus sign), separator (green), and cathode (blue, plus sign), each about 20 nanometers in size. Below are their respective molecular structures.

The world is a big place, but it's gotten smaller with the advent of technologies that put people from across the globe in the palm of one's hand. And as the world has shrunk, it has also demanded that things happen ever faster -- including the time it takes to charge an electronic device. A cross-campus collaboration led by Ulrich Wiesner, professor of engineering in the Cornell University, addresses this demand with a novel energy storage device architecture that has the potential for lightning-quick charges. The group's idea: Instead of having the batteries' anode and cathode on either side of a nonconducting separator, intertwine the components in a self-assembling, 3D gyroidal structure, with thousands of nanoscale pores filled with the elements necessary for energy storage and delivery. "This is truly a revolutionary battery architecture," said researcher Wiesner. "This three-dimensional architecture basically eliminates all losses from dead volume in your device," Wiesner said. "More importantly, shrinking the dimensions of these interpenetrated domains down to the nanoscale, as we did, gives you orders of magnitude higher power density. In other words, you can access the energy in much shorter times than what's usually done with conventional battery architectures." How fast is that? Wiesner said that, due to the dimensions of the battery's elements being shrunk down to the nanoscale, "by the time you put your cable into the socket, in seconds, perhaps even faster, the battery would be charged." The architecture for this concept is based on block copolymer self-assembly, which the Wiesner group has employed for years in other devices, including a gyroidal solar cell and a gyroidal superconductor. Joerg Werner, lead author on this work, had experimented with self-assembling photonic devices, and wondered if the same principles could be applied to carbon materials for energy storage. The gyroidal thin films of carbon -- the battery's anode, generated by block copolymer self-assembly -- featured thousands of periodic pores on the order of 40 nanometers wide. These pores were then coated with a 10 nm-thick, electronically insulating but ion-conducting separator through electropolymerization, which by the very nature of the process produced a pinhole-free separation layer. That's vital, since defects like holes in the separator are what can lead to catastrophic failure giving rise to fires in mobile devices such as cellphones and laptops. The next step is the addition of the cathode material -- in this case, sulfur -- in an amount that doesn't quite fill the remainder of the pores. Since sulfur can accept electrons but doesn't conduct electricity, the final step is backfilling with an electronically conducting polymer -- known as PEDOT (poly[3,4-ethylenedioxythiophene]). While this architecture offers proof of concept, Wiesner said, it's not without challenges. Volume changes during discharging and charging the battery gradually degrade the PEDOT charge collector, which doesn't experience the volume expansion that sulfur does. "When the sulfur expands," Wiesner said, "you have these little bits of polymer that get ripped apart, and then it doesn't reconnect when it shrinks again. This means there are pieces of the 3D battery that you then cannot access." The group is still perfecting the technique, but applied for patent protection on the proof-of-concept work.

Source https://www.sciencedaily.com/releases/2018/05/180517142522.htm

10. An Electronic Rescue Dog

This is an image of the three gas sensors developed at ETH Zurich.

Trained rescue dogs are still the best disaster workers -- their sensitive noses help them to track down people buried by earthquakes or avalanches. Like all living creatures, however, dogs need to take breaks every now and again. They are also often not immediately available in disaster areas, and dog teams have to travel from further afield. A new measuring device from researchers at ETH Zurich led by Sotiris Pratsinis, Professor of Process Engineering, however, is always ready for use. The scientists had previously developed small and extremely sensitive gas sensors for acetone, ammonia, and isoprene -- all metabolic products that we emit in low concentrations via our breath or skin. The researchers have now combined these sensors in a device with two commercial sensors for CO_2 and moisture. As shown by laboratory tests in collaboration with Austrian and Cypriot scientists, this sensor combination can be quite useful when searching for entrapped people. The researchers used a test chamber at the University of Innsbruck's Institute for Breath Research in Dornbirn as an entrapment simulator. Volunteers each remained in this chamber for two hours. "The combination of sensors for various chemical compounds is important, because the individual substances could come from sources other than humans. CO_2, for example, could come from either a buried person or a fire source," explains Andreas Güntner, a lead researcher. The combination of sensors provides the scientists with reliable indicators of the presence of people. The researchers also showed that there are differences between the compounds emitted via our breath and skin. "Acetone and isoprene are typical substances that we mostly breathe out. Ammonia, however, is usually emitted through the skin," explains ETH professor Pratsinis. In the experiments in the entrapment simulator, the participants wore a breathing mask. In the first part of the experiment, the exhaled air was channelled directly out of the chamber; in the second part, it remained inside. This allowed the scientists to create separate breath and skin emission profiles. The ETH scientists' gas sensors are the size of a small computer chip. "They are about as sensitive as most ion mobility spectrometers, which are very expensive and are the size of a suitcase," says Pratsinis. "Our easy-to-handle sensor combination is by far the smallest and cheapest device that is sufficiently sensitive to detect entrapped people. In a next step, we would like to test it during real conditions, to see whether it is suited for use in searches after earthquakes or avalanches." While electronic devices are already in use during searches after earthquakes, these work with microphones and cameras. These only help to locate entrapped people who are capable of making themselves heard or are visible beneath ruins. The ETH scientists' idea is to complement these resources with the chemical sensors. They are currently looking for industry partners or investors to support the construction of a prototype. Drones and robots could also be equipped with the gas sensors, allowing difficult-to-reach or inaccessible areas to also be searched.

Source https://www.sciencedaily.com/releases/2018/05/180516131156.htm

Cheap and Light: BARC Offers First Indigenous Bulletproof Vest

Bhabha Kavach can shield from AK-47 (hard steel bullets), SLR and INSUS weaponry; undergoing tests by armed forces

The Bhabha Atomic Reseach Centre (BARC) has developed a next-generation bulletproof jacket for the Indian armed forces, which is not only cheaper but also much lighter. Bhabha Kavach, named after nuclear physicist Dr. Homi J. Bhabha, the jacket was developed at BARC's Trombay centre in response to a request from the Central Reserve Police Force (CRPF) and the Ministry of Home Affairs. The jacket weighs just 6.6 kg in comparison to the 17-kg jackets in use and has passed over 30 tests carried out by certified agencies. Bhabha Kavach is available in three variants as per the requirement of the armed forces. A five-member BARC team worked for a year in 2015-16 to develop the jacket, which is being tested by a joint team of the CRPF, Indo-Tibetan Border Police, and the Central Industrial Security Force. The northern command of the Indian Army is also testing a variant of the jacket in Jammu and Kashmir. The jacket is made using extremely hard boron carbide ceramics that is hot-pressed with carbon nano-tubes and composite polymer. BARC has been using boron carbide in the control rods of its nuclear reactors. While the cost of a Bhabha Kavach is ₹70,000, jackets of similar strength are available in the range of ₹1.5 lakh and have to be imported. The superior performance of the light weight jacket derives from advanced ceramics and advanced nano-composite tubes indigenously developed at BARC. Presently, the forces use bulletproof jackets weighing over 10 kg and are made of jackal armour steel, alumina and silica. Jackets made using boron carbide are first in India. Bhabha Kavach has been designed to protect our soldiers against AK-47 (hard steel bullets), SLR and INSUS weaponry. BARC has transferred the technology of Bhabha Kavach to Mishra Dhatu Nigam, Hyderabad, for its large-scale production. It is estimated that about one lakh jackets will be required, per annum, for the next 10 years. BARC is now trying to improvise Bhabha Kavach based on feedback from the forces.

Source http://www.thehindu.com/news/national/bulletproof-jackets-from-barc/article23673507.ece