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From the Editor's Desk

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Chief Editor of Publications

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Corruption is generally associated with our moral decadence. Its modus operandi is infinite. It can take the form of misuse of authority, manipulation of public money, use of unfair means, fabrication of evidence, plagiarism and manipulation of data, misplaced justice, among others. A corrupt person wants to win at any cost and is willing to make any compromise. His overconfidence in his abilities leads him to take unjust, immoral and faulty steps. Greed prejudices his decisions and he becomes impulsive. Motivations for corruption may include economic gain, status, power, sexual gratification, etc. Depending on the observer's ethical and moral background an action is labelled as corrupt. Francis Bacon said, people have a natural inclination to accept, believe and even prove what they would prefer to be true. In spite of the fact that people's perception and the extent of corruption vary greatly across the world, general agreement is that corruption damages society, democracy, and economic progress.

We want to maximize our own payoffs. The higher the reward from being dishonest, the higher is the extent to which we engage ourselves to dishonest means, says Dan Ariely. We are vulnerable. We are vulnerable to attack, criticism, even temptation. We get easily wounded, or hurt. Our vulnerability and susceptibility are subjective, and depends upon our cognitive abilities, personality, and social background. In a strongly competitive environment ambition and vanity sometimes completely outweigh our ethics and our sense of fairness. Keeping quiet when one supposedly should speak is a form of dishonesty. An act of silence that is intended to cause another person to believe something that isn't true is deception.

A corrupt mind misuses the fertility of the mind. A corrupt mind becomes bolder with repeated stimulus. After tasting and liking the 'blood', a corrupt becomes more aggressive. He can do anything to fulfil his desires, and if not stopped, he becomes a bloodsucker. The problem is that the stimulus-response behaviour is so spontaneous and subconscious that it escapes the thought process of the corrupt.

Honesty and intelligence don't necessarily go hand-in-hand. Often brilliance and talent is the most dishonest combination. We often become so convinced about the rightness of our own theories that we start believing that we only have the right to be right. We like to push threatening information away from us and pull friendly information close to us. We like arguments that help us to hold our views. We dislike arguments that are likely to change our mind and opinion.

Some believe morality is grounded in our biology. They say, in us exists a 'moral organ'. Some, however, are not so sure of the existence of a moral organ inside us. Studies have indicated that morality is highly influenced by local culture and learning. We are not born corrupt. We reprogram ourselves to update our moral software. Maybe someday in the far future biological hardware will be used for updating our moral software.

To fight corruption, more than structural and legal reforms, moral renovation of the self is necessary. We need to develop innate values so as to keep us moral even in the most amoral situations. We need to refurbish ourselves with the lessons of trustworthiness, compassion, forbearance, generosity, humility, and

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Purnendu Ghosh
Chief Editor of Publications

ACADEMY ACTIVITIES

From the Editor's Desk

Opening of Facebook and Twitter Accounts by INAE

The Department of Science and Technology (DST) has recommended enhancing Social Media Optimization through creation of Facebook and Twitter accounts. Accordingly a Facebook page and Twitter Handle for INAE have been created. All INAE Fellows are requested to visit the page and post their comments, if any. The Facebook page of INAE can be viewed at https://www.facebook.com/pages/Indian-National-Academy-of-Engineering/714509531987607?ref=hl and Twitter handle at https://twitter.com/inaehq1

Research Journal -INAE Letters

INAE has recently launched a quarterly journal "INAE Letters" published by M/s Springer. The objective of the journal is to provide a medium for rapid publication of new research results and invited short review articles across different domains of engineering science and technology. The first issue of the Research Journal "INAE Letters" was released by the Shri M Venkaiah Naidu, Hon'ble Minister for Urban Development, Housing & Urban Poverty Alleviation and Information & Broadcasting on Sep 1, 2016 at IIT Madras, Chennai during the sidelines of the Engineers Conclave 2016. Dr Purnendu Ghosh, Chief Editor of Publications, INAE and Executive Director, Birla Institute for Scientific Research, Jaipur is the Editor-in-Chief of INAE Letters. The website for the Research Journal "INAE Letters" to include facility for submission of papers online has also been launched. The soft copy of the INAE Letters can be viewed at the link http://www.springer.com/engineering/journal/41403

*(**L. to R.** Dr BN Suresh, President, INAE, Shri Vinay Sheel Oberoi, Secretary, HRD; Hon'ble Minister, Shri M Venkaiah Naidu and Prof Bhaskar Ramamurthi, Director, IIT Madras during the release of INAE Letters)*

Creation of Data for INAE Expert Pool

INAE Expert Pool was created with the aim of identifying domain experts in various disciplines of engineering. There has been a good response from the Fellows and Young Associates in uploading their particulars on the INAE Expert Pool website. The INAE Fellows and Young Associates who have not uploaded their particulars are requested to submit their profile details online at the link http://inae.in/expert-search/index.php/inae-members-form The details of the INAE expert Pool have since been shared with DST, TIFAC, Niti Aayog and Office of PSA. The creation of the website on

Expert Pool has been appreciated by all the agencies and the data would be used by them in identifying suitable domain experts and to involve the experts in their activities.

Important Meetings held during November 2016

- **INAE Apex Committee Meeting on Nov 18, 2016**
- **INAE-DST Consultative Committee Meeting on Nov 19, 2016**

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 BC Pai CSIR Emeritus Scientist, CSIR, National Institute for Interdisciplinary Science and Technology (NIIST)	Government College of Engineering, Tirunelveli August 22-23, 2016	Delivered lectures on "Fracture in Engineering Materials", " Fracture in Composite Materials" and "Manufacturing in Design". According to the feedback from the faculty coordinator of the engineering college, the Industry Expert has guided 5 projects. He also has identified new areas of work titled "Understanding the mechanisms of strengthening in fiber and particle reinforced polymer composites and methods of experimental evaluation", "Micro mechanical modeling of Particle filled composites and study their physical and mechanical properties" and " The various filler reinforcement in the field of filled polymer composites and the property modeling in FEM". The interactions of the industry expert with research scholars and the faculty members have enhanced their knowledge and have encouraged them to identify new research areas.
Dr Jayanta Kumar Saha Deputy General Manager (Applications), Institute for Steel Development & Growth	Indian Institute of Engineering Sciences and Technology, Shibpur September 27-28,2016	Delivered lectures on "Useful Welding & Fabrication Processes with reference to Applicable Codes & Standards" and "Understanding of Structural Steels and Product Profile of Major Steel Producers of India". According to the feedback received from the engineering college, two new projects have been suggested by the industry expert. The feedback also mentioned that the DVP has helped to correlate applications with theoretical knowledge and has assisted in skill

		development training programme for the final year students.
Dr Chaitanyamoy Ganguly Retired Distinguished Scientist, DAE	Jadavpur University, Kolkata October 24-25, 2016	Delivered lectures on "Topics related to Nuclear Fuel Cycle I" and "Topics related to Nulclear Cycle II". As per the feedback from the faculty coordinator, the industry expert has been a source of valuable expertise to the department.

International Conferences/Seminars being organized by IITs/other Institutions

To view a list of International Conferences/Seminars being held in the month of December 2016 click here.

IEEE International Conference on Electrical, Electronics, Communication, Computer and Optimization Techniques ICEECCOT-2016 on Dec 9-10, 2016 at Mysore
http://www.conferencealerts.com/show-event?id=174035

International Conference on "Electrical Power and Energy Systems" (ICEPES 2016) on Dec 14-16, 2016 at Bhopal
http://www.conferencealerts.com/show-event?id=171295

New Delhi 5th International Conference on "Engineering & Technology, Computer, Basic & Applied Sciences" (ECBA- 2016) on Dec 14-15, 2016 at New Delhi
http://www.conferencealerts.com/show-event?id=173496

An Engineer's Prayer to the Blue Fairy

Srinivasan Ramani

As I write this article, I feel like a little boy in front of the blue fairy [1], asking her to grant me a few wishes. The fairy I address is human ingenuity, the collective abilities of millions of humans to innovate their way out to a better life. I would be very satisfied even if a few hundred engineers and students read these pages and are stimulated to try solving some of the problems discussed here. My own background ensures that I talk a bit more about Information Technology (IT) than about other matters; but, IT is not a branch of technology that works miracles in isolation. It has roles to play in almost every field of engineering and technology. It becomes particularly valuable when it is used to solve practical problems, to make us live and work better. We need to think about IT driven changes in the socio-economic context, to derive their full benefits.

Here are my wishes:

Use IT to create more jobs

IT and IT enabled services (ITES) have had a remarkable impact on the economy. They have really enabled Indian pioneers to put knowledge workers at the service of the global economy, creating jobs and contributing to our export earnings. It is amazing that already, IT and ITES contribute to India's Gross National Product more than the value of all the rice and wheat India grows annually! However, the number of jobs created by IT and ITES are not big enough to answer the challenge of job creation satisfactorily. It is easy to use IT to improve productivity and/or efficiency, but it is more difficult to use it tocreate large numbers of new jobs. This is the major boon I ask from the blue fairy! Tell us how to create more jobs using IT or otherwise. This topic is, however, complex and requires a separate article altogether. So, I will reluctantly move to the other boons I need to ask.

Get rid of the car

The revolution that will lead us to the goal is already in progress, but we need to speed it up. A written definition of the goal will help. I would like to have a virtual car as my next car. It should be

available anywhere, anytime. Tap an app on my cell phone and optionally enter a destination and time of departure; I should have the driver calling me up, and turning up in a few minutes to take me where I wish to go. This is already there, is it not? Let us look at what is not there. For one thing, I have not got rid of my car! It wastes parking space in my building, and in the places I visit. We have not recognized the virtual car as a real solution to traffic problems and atmospheric pollution in the next few decades. We have not visualized that it can create employment in significant numbers. We have only grudgingly accepted it as yet another enterprise and have done nothing to promote it. The issue is not one of administrative decisions; it is about the right visions for the transportation system of the future. Unless society recognizes that IT has made it unnecessary to have personal vehicles in most cases and creates the right policies, we will continue to have a moribund system of transportation. What are required are tax incentives to promote the use of shared vehicles, encouraging investments in companies providing shared vehicles, and support to employment generation in the form of a large number of drivers. The use of shared vehicles will reduce the wasteful investment in vehicles, because shared vehicles are far more productive. It also increases the productivity of drivers as it avoids drivers having to waste their time waiting for private car owners. The money required to buy a personal car is enough to build some accommodation for a rural family, or to create a job for someone. The efficiency of rented vehicles will vastly make our road infrastructure more productive.

Make the buses more user-friendly

Buses have to provide for the bulk of intra-city and intra-district transport capacity. One reason car or bike ownership is preferred by those who can afford them is that buses are an unfriendly lot as they work today. The IT revolution offers solutions to make them more efficient and easy to use. The App based Taxi business shows how easy it is to display the location and movement of a vehicle on anyone's smartphone. Why can't every bus be a 'thing on the Internet'? Why can't my cell phone show me when the next bus going to Gandhi Market will reach my bus stop and whether it has a few empty seats or not, using information picked up from a smart phones equipped with a suitable apps that can be installed in every bus? After all, the GPS system enables the cell phones to find out where they are from minute to minute. Why can't we centralize and use such information in every city, to control real-time allocation of buses to different routes to make them more responsive to demands?

Containerizing retail delivery

E-commerce has made it so much easier to order anything from vegetables to cameras and clothes much simpler and more efficient. The volume of goods delivered is increasing steadily. E-

commerce reduces the need for going out to buy things as and when needed, as well as the need to stock up things for future use. As a result, it improves efficiency of the economy and promotes better use of resources. E-commerce ending with retail delivery of physical goods is not yet a major part of the retail sector in India, but is a rapidly growing part. A concern about this business is the fact that it consumes a lot of packing material and creates a whole lot of waste. Garbage disposal is already a big problem in Indian metros and the growth of online purchases of retail goods will surely make this problem worse. There is a need for India to be pro-active and find solutions to the problems that E-commerce could create.

I believe that the solution is to containerize retail delivery, by inventing cost-effective, re-usable containers. Plastics manufacturers are already making containers for use by E-tailers to deliver perishables. However, there is no standardization and no significant efforts have gone into designing ideal containers. The problem is not merely a problem for India, but one for the world. Good solutions should preferably be globally acceptable ones. This will mean cooperation and learning from others as we finalize our designs, but it does not mean that we cannot hope to make major advances. With luck, we might even develop an export market in containers!

Making Electricity Supply more reliable

I believe that we are at a major inflection point in terms of the production and distribution of electricity. For a variety of reasons, including political ones, we have an electric supply system that does not promote efficiency and productivity. Most Indian cities and towns do not adhere to good standards in electricity distribution. Frequent interruptions of power supply damage equipment and reduce productivity of the economy as a whole. All this ends up increasing the cost of goods produced and services created. A major advance would promote the use of distributed generation of energy, increasing the robustness of the overall supply system. A good part of this distributed production could come from solar panels. Throughout the world, miscellaneous technical and economic arguments are advanced to resist such distributed energy creation. It is important that India figures out its own solutions to the problems envisaged. For instance, an energy production unit in customer premises could put at risk the lives of wiremen working for the centralized electricity distributor, by sending out power to a line they are repairing. Surely, Indians can invest suitable technical safeguards against such risks. The cost of protection systems would easily be justified by the benefits of permitting small units to produce electricity at customer premises. India should not wait for others to develop relevant technology to make this practical. The effective use of solar energy surely requires advanced battery technology. India should make its own contributions to this field.

Incidentally, I am writing this article in Bangalore in October. The power has tripped about twenty times during the writing of this article. The building's diesel generator kept coming up to meet every trip. The UPS under my table did its bit, but with all this, it was difficult to avoid repeated interruptions of my work.

Standardized financial reporting

If you use a credit card, or if one of your cheques is encashed, you get an email, an SMS, or both depending upon the preferences you have indicated. Every month, you also get a bank statement for every account you have. Mutual funds and other investment managers send their own periodic reports as well. At the end of the year, you hand over relevant statements to someone who first types in everything, to create an integrated picture of your income and expenditure. This is a good example of a very inefficient system in which an intelligent human being has to retype into a common format what has been received electronically in different formats. Yes, it does create a job for a human, but a tragic dead-end job, which adds no real value to the economy! You might as well pay him his salary and have him do something he enjoys doing, like learning music or bodybuilding! The tax consultant does not send you the integrated account created by him; he says that such and such software is required to open it, and that software is not meantfor customer use! Therefore, you, the customer, never get to access an integrated financial record of your own.

It is not very difficult to design a computer readable format, for sending reports of financial transactions. A suitable app on a computer or on a cell phone at the customer end can display the contents in a form suitable for the end-user to examine. Software can integrate multiple reports into a complete personal record of incomes and expenditures for the year. Reports should help us understand our situation, not merely meet some legal reporting requirement! Promoting a common reporting format is the responsibility of the concerned regulatory authority. Government departments concerned with efficiency and transparency in the financial sector also carry their share of responsibility in this regard.

Satellite based text messaging

There are many places in the country where cell phone connectivity is non-existent or poor, such as rural areas that do not generate attractive enough profits for cell phone companies, and hilly areas where the topology makes it difficult for cell phone company towers to cover the territory. There are problems that can be solved technically but are made difficult by administrative and political considerations. For instance, you might have a cell phone that works well where you live, but the company that provides the service does not usually support roaming in rural areas that are mostly

covered by a public sector company. So there are places that have cell phone coverage, but where your phone does not work. This is apart from areas where no cell phone works anyway!

Because of the problems described above, one cannot depend upon cell phones for providing communication in times of personal accident and in times of disaster that affect large numbers of people. Cellular communication failed whole villages and districts during floods in Himachal Pradesh a few years ago; media reported that electrical power supply was interrupted and that diesel fuel ran out in a few days in many places, and so cell towers stopped working.

I would like to ask the blue fairy – grant us a wish: we would like to have a system using communication satellites to enable affordable cellphones to send and receive at least text messages. We would like this system to work without depending upon a cellular communication tower being within a few miles of the customer location. We do not mind if the messages are routed through ground stations operated by profit making companies. We do not mind if the messages are subject to legally approved tapping by government agencies to prevent anti-social elements misusing the system. We do not mind paying reasonable extra charges for such satellite-based communication. We would like the system to support the use of scripts of all major Indian languages. Give us a system that is reliable, works everywhere and is affordable for the vast majority of users.

I will rest with these requests, my dear fairy! You, in the form of human ingenuity, have given so much and will no doubt give us a lot more in future.

1. "The Adventures of Pinocchio" by Carlo Collodi, http://fathom.lib.uchicago.edu/2/72810000/72810000_pinocchio.pdf

   (The Walt Disney adaptation of this story turned the fairy in this story into the "Blue Fairy").

CATALYSIS FOR TRANSFORMING BIOMASS TO VALUE ADDED CHEMICALS

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Abstract Although fossil fuels will continue to be the prime energy source for next few years, its limited reserves and environmental impact drives us to initiate the transition to renewable and clean energy resources. Among various renewable energy options, biomass occupies a unique position because it is, (i) most abundant and carbon neutral, (ii) acts as energy collector and storage system, (iii) the only large-scale energy source, (iv) available at low capital cost and (v) source of various value added chemicals, befitting to the concept of 'Biorefinery'. This paper presents a summary of our recent work on catalyst and process development for conversion of biomass derived molecules such as glycerol, levulinic acid and furfural to the respective diols, ring lactones and heterocycles having applications in variety of sectors including fuel and commodity.
Keywords: Biorefinery, catalytic, hydrogenation, bioglycerol, levulinic acid, propanediol,

1. Introduction

Crude oil which is non-regenerative has been serving as a prime feed stock for about a century for fuel and synthetic materials of the modern society. A paradigm shift towards sustainability and reduction in carbon footprints evolved the concept of biorefinery based on utilization of renewable biomass feedstock for producing biofuels and chemicals, which has the potential for commercialization in near future [Rode et al. (2014)]. As shown in Fig. 1, 'Biorefinery' concept is very similar to the conventional petro-refinery that produces multiple fuels and products in an integrated complex, biomass transformation to value added chemicals is possible either chemically or biologically using microorganisms. The catalysts and the processes being used in petro-refinery are mainly for the selective functionalization of hydrocarbons. On the other hand, new catalyst systems and tandem approaches need to be designed for biorefinery applications. This is because, biomass derived molecules are highly functionalized which demand selective removal of some functionalities with minimum number of steps from economic point of view. Biorefinery has several distinct advantages such as (i) lower net greenhouse gas generation (ii) bio-molecules such as carbohydrates invariably contain more than one oxygen atom hence, selective deoxygenation is necessary to obtain chemicals with less number of oxygen atoms. In the beginning of the 21st century, major attention was focused on new catalysts and routes for the conversion of several biobased platform molecules into fuels and multiple commodity products. Designing appropriate catalyst systems for selective deoxygenation of highly oxygenated bioderived molecules to platform chemicals and products is one of the most important challenges to realize the bio-refinery concept in near future. For economical and ethical reasons, anticipated large-scale production of biofuels will be possible from lignocellusic biomass. While more value added platform and specialty chemicals required in relatively low volumes can be obtained from functionalized sugars, vegetable oils and terpenes. Hence, developing catalysts and processes for high-value chemicals from biomass derived molecules is much more attractive commercially. However, due to the complex nature of biomass molecules as compared to simple hydrocarbons, selective formation of fine and platform molecules has proven much more demanding and troublesome

from technical consideration. The major solutions to such problems come from designing multifunctional catalysts aiming at tandem syntheses. In such approaches, reactor and process engineering innovations play an important role e.g. mass and heat transfer in case of multiphase reactions such as hydrogenation, for removal of the intermediate product formed and / or introduction of another reactant after commencement of the reaction, product separation and recovery etc. This paper summarizes our recent work on catalyst and laboratory scale process development exemplified by hydrodeoxygenation and / or hydrogenation of three important building blocks *viz.* glycerol, levulinic acid and furfural to the corresponding value-added diols, ring lactones and heterocyclic compounds.

Among these substrates, glycerol is the smallest, highly functionalized polyol and constitutes first as well as second generation biomass product as it is obtained as a by-product in (i) biodiesel production (ii) industrial conversion of lignocelluloses into ethanol and/or hydrogenolysis of sorbitol. The selective dehydration of glycerol and its subsequent hydrogenation (hydrodexygenation) gives two industrially important products *viz.* acetol and 1,2-propanediol (1,2-PDO), respectively, having industrial applications [Mane and Rode (2014)]. Similarly, levulinic acid sourced from cellulosic biomass is hydrogenated to a ring lactone *viz.* γ-valerolactone (GVL) having applications as a fuel additive and as a green solvent. After developing the catalysts and hydrogenation routes typically using an external hydrogen, we also successfully established the hydrogenation without using external hydrogen either by aqueous phase reforming (APR) or by transfer hydrogenation routes. In case of furfural as a substrate, its direct conversion of to tetrahydrofuran required Pd catalyst which involved the tandem route comprising decarbonylation and hydrogenation reactions.

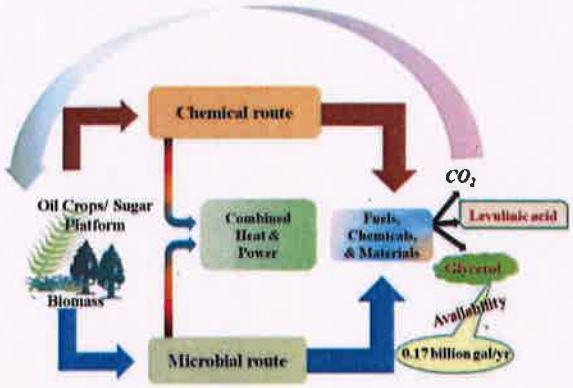
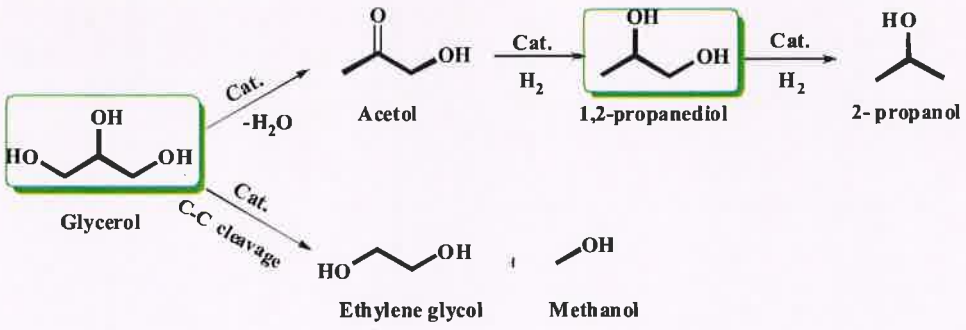


Figure 1. Biorefinery concept

2. Results and discussion

2.1. Dehydration and hydrogenolysis of aqueous glycerol

Among several value-added chemicals possible from glycerol, 1,2-propaendiol (1,2-PDO) is one of the most important commercial product obtained by catalytic hydrogenolysis of glycerol. This transformation involves first step glycerol dehydration to acetol followed by its hydrogenation to 1,2-PDO (**Scheme 1**).



Scheme 1. Pathway for dehydration followed by hydrogenation of glycerol

The glycerol dehydration intermediate, acetol also has wide range applications in hydrogen production and pyruvaldehyde synthesis through oxidation and as a starting material in various organic transformations. Most of the studies on glycerol dehydration were mainly carried out in vapor phase at higher temperature in which the acetol selectivity was affected because of acrolein and other byproducts formation. These processes are also accompanied by fast catalyst deactivation due to extensive coke deposition. In our efforts, we developed Cat-2 and Cat-3 catalysts which gave acetol selectivity of 100% and 90% with glycerol conversion of 32 and 34%, respectively, in 2- propanol solvent. This is due to the highest acidity of these two catalysts (Table 1) as the glycerol dehydration is an acid catalyzed reaction. A detailed study of glycerol dehydration in aqueous medium was also carried out under inert atmosphere

Table 1. Catalyst screening for glycerol dehydration to acetol

Catalysts	Acid strength (NH_3 mmole/g)	Conv. (%)	Selectivity (%)			
			Acetol	1,2-PDO	EG	Others
Cat-1 (Cu-Cr)	0.3414	37	86	14	-	-
Cat-2 (Cu-Cr-Al-Zn)	1.153	32	100	-	-	-
Cat-3(Cu-Cr-Al-Ba)	1.021	34	90	8	2	-
Cat-4(Cu-Cr-Zn)	0.7856	38	55	7	-	38

over Cu catalysts modified by oxides of different metals such as Al, Zn, Zr, Mg and Ba. Interestingly, only Al and Zr in combination with Cu showed excellent dehydration activity. It was concluded that glycerol dehydration to acetol needed both Bronsted as well as reduced Cu active sites [Mane et al. (2013)].

Glycerol hydrogenolysis to 1,2-PDO has been largely exploited even for pilot and commercial scale trials over copper chromite catalysts. Due to the toxicity associated with Cr, we developed highly efficient non-chromium and non-noble nano Cu-Al catalyst, which was prepared by simple simultaneous co-precipitation digestion technique [Mane *et al.* (2010), Mane and Rode (2012)]. This new Cu-Al catalyst showed highest activity in both the solvents with the highest selectivity of 91% to 1,2-PDO for aqueous phase hydrogenolysis of glycerol in a very short reaction time of 5 h [Rode et al. (2014)]. The detail physico-chemical characterization of this catalysts revealed that the presence of stable particle size of 7–11 nm, inhibition of sintering of the active phase (Cu^0) due to presence of Cu_2O, as evidenced by XRD and the higher acidity (1.567 mmol NH_3 g^{-1}) of Cu-Al catalyst were responsible for its higher activity for glycerol hydrogenolysis. As shown in Figure 1, this catalyst gave a TOS activity of 400 h for continuous hydrogenolysis of glycerol with an average glycerol conversion of 65% and >90%

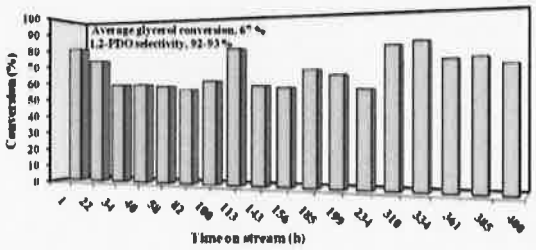


Figure 1. TOS of NCL catalyst for glycerol hydrogenolysis to 1,2-PDO

selectivity to 1,2-PDO [Mane and Rode (2013)]. The same catalyst was also effective for *in-situ* glycerol hydrogenolysis *via* aqueous phase glycerol reforming showing TOS of 400 h, due to its multifunctional sites [Mane and Rode (2012)].

The advantages of the NCL process are:

- Sustainable process for 1,2-PDO as it uses bio-derived glycerol as a feedstock
- Environmentally clean process as it doesnot produce byproducts which create effluent disposal problems
- Catalyst system composed of non-chromium, non-noble metals hence attractive process economics.
- Glycerol co-generated in bio-diesel process can be used with minimum pretreatment giving 1,2-PDO selectivity of > 75% with EG and lower alcohols, the later being volatile can be easily removed while the

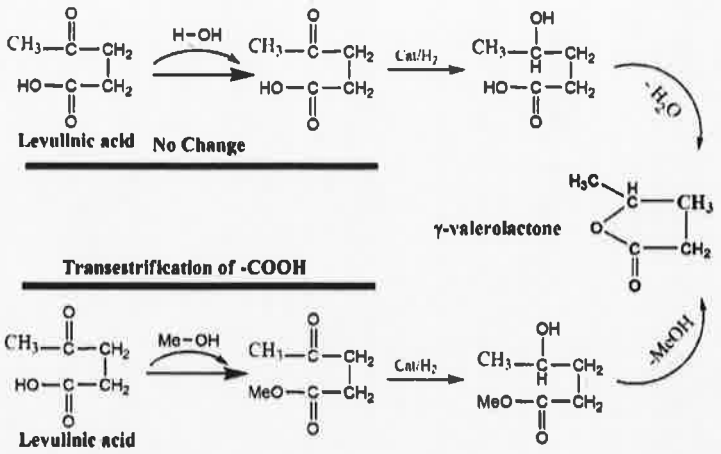
product mix of 1,2-PDO and EG can be directly used as functional fluid.

Based on the continuous process operation results of NCL, complete mass balance across the reactor was done and the process economics has been also completed for a 25000 TPA 1,2-PDO production by Praj Ind. Downstream processing of the reactor crude has been proposed using the ASPEN PLUS Simulator, which involves three distillation columns. Water and acetol are mainly separated out in the first column along with the volatiles while the distillate of column 2, gives 1,2-PDO and EG under reduced pressure. 1,2-PDO (99.5%) is distilled out from column 3 leaving EG as the bottom product. Considering CAPEX and OPEX (including the feedstock cost and credit for EG), 1,2-PDO costing obtained was Rs. 69/kg. The project becomes more attractive particularly, for bio-glycerol cost < Rs. 45/kg considering 1, 2-PDO price of 90 Rs/kg and 100 crore capital investment. NCL proprietary catalyst is being prepared commercially by Sud-Chemie (India) which also showed the performance similar to the laboratory trials and the negotiations for commercialization of the process are in progress with some of the clients.

2.2 Hydrogenation of levulinic esters to γ-valerolactone (GVL)

A plethora of functionalized molecules can be derived from cellulosic biomass, which is available cheaply in large quantities all over the globe. Pacific Northwest National Laboratory (PNNL) and US National Renewable Energy Laboratory (NREL) have identified twelve such resource chemicals having potential industrial applications including chemical and fuel products [Gurbuz et al. (2011); Rode atl. (2014)]. Levulinic acid (LA) is one of the important compounds among these molecules for the biorefinery application. The commercial production of LA is offered by the well known Biofine process [Fitzpatrick (2006)]. This becomes a proven approach to convert cellulosic biomass to valuable platform chemicals, specifically levulinic acid (C6 fraction) and furfural (C5 fraction) with levulinic acid yield up to 70–80%, corresponding to 50% of the mass of the C6 sugars. The remaining mass is collected as formic acid (20%) and a solid residue called humins (30%), due to degradation of the large number of intermediates and lignin.

Catalytic hydrogenation of LA and its esters to γ-valerolactone (GVL) (Scheme 2) is of great commercial importance as GVL is the key product due to its benign properties and versatility with which it can be converted to downstream applications for the next generation fuel and fuel additives [Serrano-Ruiz *et al.* (2010)]. The subsequent hydrogenation product of GVL is pentanoic acid having most desirable applications as fuel/fuel additives [Lange et al. (2007)]. We have developed non noble metal nanocomposite catalysts comprising Cu and Zr for the first time for selective hydrogenation of levulinic acid and its methyl ester to GVL, the later is more advantageous due to (i) suppression of active metal leaching of hydrogenation catalyst caused by free carboxyl of levulinic acid and (ii) recyclability of alcohol formed during hydrogenation [Hengne and Rode, Green Chem. 2012]. HRTEM revealed the particle size of copper in a range of 10-14nm. Both XRD and Raman spectroscopy confirmed the formation of Cu-ZrO_2 nanocomposite and also the presence of mixed oxide phases along with Cu^0. Both the catalysts showed complete conversion of LA and its ester with >90% selectivity to GVL. Cu-ZrO_2 catalyst could be recycled efficiently for four times with almost no leaching of active metal, for LA hydrogenation in methanol.



Scheme 2: Pathway of LA hydrogenation in water and in MeOH.

2.3 Furfural hydrogenation

Furfural (FFR) is another highly functionalized molecule obtained by acid hydrolysis of pentose sugars C5 (Xylose, arbinose) followed by dehydration. The catalytic hydrogenation of its side chain carbonyl and / or the ring gives an array of products such as furfuryl alcohol (FAL), tetrahydrofurfuryl alcohol (THFAL), 2-methylfuran (2-MF) and 2-methyl tetrahydrofuran (2-MTHF), useful in various applications. One of these products, THFAL is a 'green' industrial solvent due to its biodegradable nature. THFAL is conventionally produced by a two step catalytic hydrogenation of furfural (FFR) to furfuryl alcohol over Cu-Cr first and then its hydrogenation using noble metal catalysts separately. We have reported for the first time, direct selective hydrogenation of furfural to THFAL over Pd supported on MFI giving complete conversion of FFR [Biradar et al. (2014)]. Pd incorporation resulted in the transformation from mesoporous to microporous characteristic of structured MFI for achieving the highest selectivity to THFAL trough this direct pathway (Table 2). The silicalite crystals of MFI possessed hexagonal morphology with a flip structure matching with an orthorhombic symmetry of zeolite phase. The catalyst stability was demonstrated by its consistent performance up to four recycles.

Table 2. Catalyst screening for furfural hydrogenation

Sr. No.	Catalyst	Conversion %	Selectivity %					
			FAL	THFAL	MF	MTHF	THF	Other
1	3%Pd/MFI	93	31	67	--	--	2	--
2	3%Pd/SiO_2	76	50	31	--	--	--	19
3	3%Pd/SnMFI	72	49	30	1	--	2	6
4	3%Ru/MFI	100	79	13	2	--	--	3

5	3%Pd-3%Ru-MFI	98	29	49	4	1	3	5
6	3%Pd-20%Cu-MFI	100	91	--	--	--	--	--
7	3%Pd/MFI	84	SM	99	1	--	--	--

Reaction Conditions: Substrate, 5% (W/W); Solvent, Isopropyl alcohol (95 ml); Temperature, 493K; Pressure 500 psi; Agitation Speed, 1000 rpm; Catalyst, (3%Pd/MFI), 0.5 gm; Reaction time 5 h.

3 Summary and Conclusions

The rapid growth in glycerol availability from bio-diesel production and soap splitting as well as its highly functionalized nature makes the initiation point for developing new products and/or new routes for the existing fossil-derived products, from glycerol. Among these, 1, 2-PDO is an important commodity chemical obtained by hydrogenolysis of glycerol. With a global demand of 1.5 million tones/yr and an annual growth rate of 4% @ $ 1.6 / kg, 1,2-PDO is used in the production of antifreeze functional fluids, paints, humectants, and polyester resins. NCL team has successfully developed a highly efficient and stable, non-noble metal Cu based catalyst and a feasibility of bench scale continuous hydrogenolysis process for 1,2-PDO from glycerol, under NMITLI program. Laboratory scale (23 g catalyst) continuous process testing showed TOS of 500 h giving > 80% glycerol conversion with > 91% selectivity to 1,2-PDO. The major by-products formed were acetol and ethylene glycol. Feed tested was 60% aq. refined bio-glycerol procured from the international market. This process was further evaluated on a pilot scale (400 g catalyst) for TOS of 300 h with performance same as laboratory scale trials. For this purpose, catalyst preparation was also scaled up to 1 kg level at NCL and the catalyst was formulated in the form of 5 x 5 mm pellets. A protocol has been standardized for in-situ calcination and activation of the catalyst. Based on the continuous process operation results of NCL, complete mass balance across the reactor was done and the process economics has been also completed for a 25000 TPA 1,2-PDO production. Downstream processing of the reactor crude has been proposed using the ASPEN PLUS Simulator, which involves three distillation columns. MOU also has been signed with a catalyst manufacturer for commercial production of NCL proprietary catalyst and the catalyst evaluation trails are underway.

In another example, cellulosic biomass derived, levulinic acid was selectively hydrogenated to GVL, a fuel additive over another non-noble metal NCL proprietary catalyst. The metal leaching was completely suppressed when the hydrogenation was preceded by in-situ esterification of LA in presence of methanol. In case of direct hydrogenatin of furfural, the support modification was done by incorporation of the active metal function. Thus, the results of our work clearly highlight the techo-economic feasibility of catalytic routes for conversion of biomass derived molecules to value added products and establish the initial steps towards realization of biorefinery concept.

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Civil Engineering

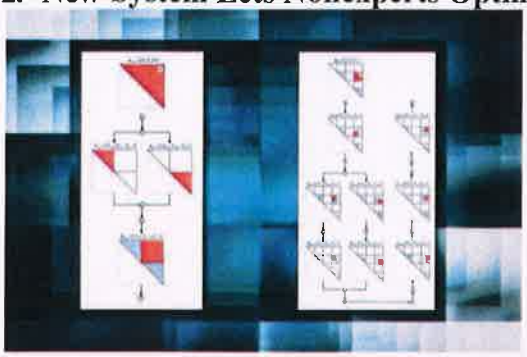
1. Japan Maglev Train Sets World Record

A Japan Railway Maglev train hit 603 kilometers per hour (374 miles per hour) on an experimental track in Yamanashi last month, setting a decisive new world record. A spokesperson said the train spent 10.8 seconds travelling above 600 kilometers per hour, during which it covered 1.8 kilometers (1.1 miles). That's nearly 20 football fields in the time it took you to read the last two sentences. The train broke its own earlier record when it ran at 590 kilometers per hour (366 miles per hour) on a test track. Japan's trains as safe as they are fast. That beat the old record of 581 kilometers per hour (361 miles per hour), which was set in 2003 during another Japanese maglev test. Right now, China operates the world's fastest commercial maglev, which has hit 431 kilometers per hour (268 miles per hour) on a route through Shanghai. By contrast, the fastest train in the United States, Amtrak's Acela Express, is only capable of 241 kilometers per hour (150 miles per hour), though it usually plods along at half that speed. Unlike traditional trains, maglev trains work by using magnets to push the train away from the tracks and drive the train forward. A Japanese maglev train during a test run. Japan's maglevs does not use metal tracks — instead, they float nearly 10 cm (4 inches) above special guideways, allowing for frictionless movement. Japan Railways has been testing their train to figure out the best operational speed for a planned route between Tokyo and Nagoya, scheduled to begin service in 2027. That trip can take nearly 5 hours by car. But in the future, a Maglev train could finish the journey in 40 minutes.

Source http://edition.cnn.com/2015/04/21/asia/japan-maglev-train-world-record/

Computer Engineering and Information Technology

2. New System Lets Nonexperts Optimize Programs That Run On Multiprocessor Chips



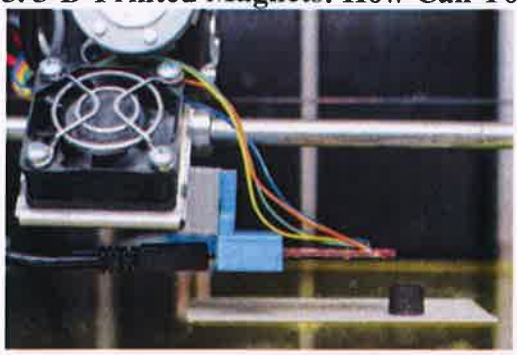
A system developed by researchers at MIT and Stony Brook University should make it easier for researchers to solve complex computational problems using dynamic programming optimized for multicore chips.

Researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) and Stony Brook University have created a new system that allows users to describe what they want their programs to do in very general terms. It then automatically produces versions of those programs that are optimized to run on multicore chips. It also guarantees that the new versions will yield exactly the same results that the single-core versions would, albeit much faster. In experiments, the researchers used the system to "parallelize" several algorithms that used dynamic programming, splitting them up so that they would run on multicore chips. The resulting programs were between three and 11 times as fast as those produced by earlier techniques for automatic parallelization, and they were generally as efficient as those that were hand-parallelized by computer scientists. Dynamic programming offers exponential speedups on a certain class of problems because it stores and reuses the results of computations, rather than recomputing them every time they're required. "But you need more memory, because you store the results of intermediate computations," says Shachar Itzhaky, an associate professor of electrical engineering and computer science at MIT. "When you come to implement it, you realize that you don't get as much speedup as you thought you would, because the memory is slow. When you store and fetch, of course, it's still faster than redoing the computation, but it's not as fast as it could have been." Computer scientists avoid this problem by reordering computations so that those requiring a particular stored value are executed in sequence, minimizing the number of times that the value has to be recalled from memory. That's relatively easy to do with a single-core computer, but with multicore computers, when multiple cores are sharing data stored at multiple locations, memory management become much more complex. A hand-optimized, parallel version of a dynamic-programming algorithm is typically 10 times as long as the single-core version, and the individual lines of code are more complex, to boot. The CSAIL researchers' new system—dubbed Bellmania, after Richard Bellman, the applied mathematician who pioneered dynamic programming—adopts a parallelization strategy called recursive divide-and-conquer. Suppose that the task of a parallel algorithm is to perform a sequence of computations on a grid of numbers, known as a matrix. Its first task might be to divide the grid into four parts, each to be processed separately. But then it might divide each of those four parts into four parts, and each of those into another four parts, and so on. Because this approach—recursion—involves breaking a problem into smaller subproblems, it naturally lends itself to parallelization. With Bellmania, the user simply has to describe the first step of the process—the division of the matrix and the procedures to be applied to the resulting segments. Bellmania then determines how to continue subdividing the problem so as to use memory efficiently. At each level of recursion—with each successively smaller subdivision of the matrix—a program generated by Bellmania will typically perform some operation on some segment of the matrix and farm the rest out to subroutines, which can be performed in parallel. Each of those subroutines, in turn, will perform some operation on some segment of the data and farm the rest out to further subroutines, and so on. Bellmania determines how much data should be processed at each level and which subroutines should handle the rest. Bellmania takes about 15 minutes to parallelize a typical dynamic-programming algorithm. That's still much faster than a human programmer could perform the same task, however. And the result is guaranteed to be correct; hand-optimized code is so complex that it's easy for errors to creep in. The types of applications that they would enable range from computational biology, to proteomics, to cybersecurity, to sorting, to scheduling problems of all sorts, to managing network traffic.

Source http://phys.org/news/2016-11-nonexperts-optimize-multiprocessor-chips.html

Mechanical Engineering

3. 3-D-Printed Magnets: How Can You Produce a Magnet with Exactly the Right Magnetic Field?



A magentic cup-like shape, created in the 3D-printer.

Today, manufacturing strong magnets is no problem from a technical perspective. It is, however, difficult to produce a permanent magnet with a magnetic field of a specific pre-determined shape. That is, until now, thanks to the new solution devised at TU Wien: for the first time ever, permanent magnets can be produced using a 3D printer. This allows magnets to be produced in complex forms and precisely customised magnetic fields, required, for example, in magnetic sensors. "The strength of a magnetic field is not the only factor," says Dieter Süss, Head of the Christian-Doppler Advanced Magnetic Sensing and Materials laboratory at TU Wien. "We often require special magnetic fields, with field lines arranged in a very specific way -- such as a magnetic field that is relatively constant in one direction, but which varies in strength in another direction." In order to achieve such requirements, magnets must be produced with a sophisticated geometric form. "A magnet can be designed on a computer, adjusting its shape until all requirements for its magnetic field are met," explains a researcher. But once you have the desired geometric shape, how do you go about implementing the design? The injection moulding process is one solution, but this requires the creation of a mould, which is time-consuming and expensive, rendering this method barely worthwhile for producing small quantities. Now, there is a much simpler method: the first-ever 3D printer which can be used to produce magnetic materials, created at TU Wien. 3D printers which generate plastic structures have existed for some time, and the magnet printer functions in much the same way. The difference is that the magnet printer uses specially produced filaments of magnetic micro granulate, which is held together by a polymer binding material. The printer heats the material and applies it point by point in the desired locations using a nozzle. The result is a three-dimensional object composed of roughly 90% magnetic material and 10% plastic. The end product is not yet magnetic, however, because the granulate is deployed in an unmagnetised state. At the very end of the process, the finished article is exposed to a strong external magnetic field, converting it into a permanent magnet. "This method allows us to process various magnetic materials, such as the exceptionally strong neodymium iron boron magnets," explains Dieter Süss. "Magnet designs created using a computer can now be quickly and precisely implemented -- at a size ranging from just a few centimetres through to decimetres, with an accuracy of well under a single millimetre." Not only is this new process fast and cost-effective, it also opens up new possibilities which would be inconceivable with other techniques: you can use different materials within a single magnet to create a smooth transition between strong and weak magnetism, for instance. "Now we will test the limits of how far we can go -- but for now it is certain that 3D printing brings something to magnet design which we could previously only dream of," declares Dieter Süss.

Source https://www.sciencedaily.com/releases/2016/10/161025115757.htm

4. Liquid Crystal Design Method Could Speed Development of Cheap Chemical Sensors

University of Wisconsin-Madison chemical engineers have developed a new way to create inexpensive chemical sensors for detecting explosives, industrial pollutants or even the chemical markers of disease in a patient's breath. Manos Mavrikakis and Nicholas L. Abbott, UW-Madison professors of chemical and biological engineering, combined their expertise in computational chemistry and liquid crystals to turn a sensor Abbott built to detect a molecular mimic of deadly sarin gas into a roadmap for tuning similar sensors to flag other dangerous or important chemicals. "We've established a new framework," says Mavrikakis. Their framework is a new approach for optimizing the components -- similar to those found in flat-panel TVs -- of a liquid-crystal-based sensor: metal cations (positively charged ions), salt anions, solvents and molecules that form liquid crystals. The research leveraged Mavrikakis' computational chemistry expertise and Abbott's experimental expertise, cycling between quantum chemical modeling and the laboratory experiments to optimize the sensor components for a targeted substance. By tweaking each of the individual components in turn, they identified an ideal configuration that specifically responded to the molecule they wanted to sense, called the analyte. The same approach could yield new sensors for a host of different analytes. In the future, for example, such materials could be used to indicate the freshness of fish or meat based on the presence of trace amounts of the foul-smelling molecule cadaverine. Another variation might be used to detect respiratory diseases based on analysis of small molecules such as nitric oxide in breath. Making such specific and sensitive materials in the lab is no easy undertaking. For complicated sensors that involve multiple components, mixing and matching chemicals in hopes of stumbling across the perfect combination is laborious and inefficient. Instead of years of trial and error, the researchers turned to computer simulations before attempting experiments in the lab. "This is indeed the first time that computational chemistry with quantum mechanics has been used to put together a coherent way of thinking for narrowing down possible solutions for an explosively complicated problem," says Mavrikakis. And after identifying promising candidates, the researchers used real-world measurements to further refine and improve their computational models. The sensor material consists of a thin film of metal salt, with liquid crystals anchored to the surface all pointing in the same direction. The researchers designed specific liquid crystal molecules and metal cations so that small amounts of analyte would disrupt the interactions of the liquid crystals with the surface, and throw the ordered arrangement into disarray. The change in the liquid crystal would be a visible indicator of the analyte's presence. Unlike expensive explosive-detecting puffer machines in airports that rely on complicated mass spectrometry or high-performance liquid chromatography equipment, these liquid crystal sensors could be portable, wearable and inexpensive. The researchers plan to explore new combinations for additional analytes and develop new liquid crystalline molecules, in combination with other metal salts and solvents, to make even more sensitive and selective sensors.

Source https://www.sciencedaily.com/releases/2016/11/161103122237.htm

Electrical Engineering

5. Ultra-Fast 2-D and 3-D Printing: Major Advance in Field of High-Speed Beam-Scanning Devices

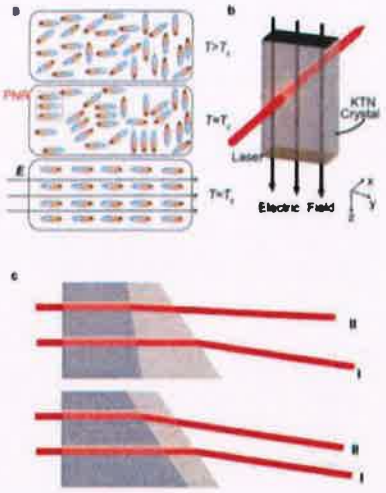


Illustration of a KTN crystal operating under different phases.

A major technological advance in the field of high-speed beam-scanning devices has increased the speed of 2D and 3D printing by up to 1000 times, according to researchers in Penn State's College of Engineering. Using a space-charge-controlled KTN beam deflector -- a kind of crystal made of potassium tantalate and potassium niobate -- with a large electro-optic effect, researchers have found that scanning at a much higher speed is possible."Basically, when the crystal materials are applied to an electric field, they generate uniform reflecting distributions, that can deflect an incoming light beam," said Shizhuo Yin, professor of electrical engineering in the School of Electrical Engineering and Computer Science. "We conducted a systematic study on indications of speed and found out the phase transition of the electric field is one of the limiting factors." To overcome this issue, Yin and his team of researchers eliminated the electric field-induced phase transition in a nanodisordered KTN crystal by making it work at a higher temperature. They not only went beyond the Curie temperature (the temperature in which certain materials lose their magnetic properties, replaced by induced magnetism), they went beyond the critical end point (in which a liquid and its vapour can coexist). This increased the scanning speed from the microsecond range to the nanosecond regime and improved high-speed imaging, broadband optical communications, and ultrafast laser display and printing. Yin said technology like this would be especially meaningful in the medical industry -- high-speed imaging would now be in real-time. For example, optometrists who use a non-invasive imaging test that uses light waves to take cross-section pictures of a person's retina, would be able to have the 3D image of their patients' retinas as they are performing the surgery, so they can see what needs to be corrected during the procedure. Yin added that this research could benefit everyone, in that something being printed in 3D that once took an hour would now take seconds, and 20,000 pages printed in 2D would take one minute.

Source https://www.sciencedaily.com/releases/2016/11/161102101335.htm

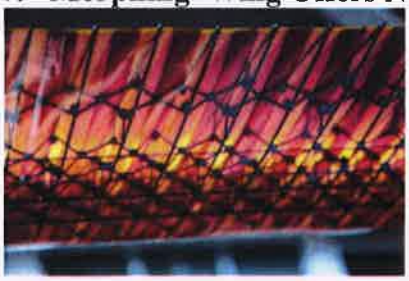
6. Semiconductor-Free Microelectronics are Now Possible, Thanks to Metamaterials

Engineers at the University of California San Diego have fabricated the first semiconductor-free, optically-controlled microelectronic device. Using metamaterials, engineers were able to build a microscale device that shows a 1,000 percent increase in conductivity when activated by low voltage and a low power laser. The discovery paves the way for microelectronic devices that are faster and capable of handling more power, and could also lead to more efficient solar panels. The capabilities of existing microelectronic devices, such as transistors, are ultimately limited by the properties of their constituent materials, such as their semiconductors, researchers said. For example, semiconductors can impose limits on a device's conductivity, or electron flow. Semiconductors have what's called a band gap, meaning they require a boost of external energy to get electrons to flow through them. And electron velocity is limited, since electrons are constantly colliding with atoms as they flow through the semiconductor. A team of researchers in the Applied Electromagnetics Group led by electrical engineering professor Dan Sievenpiper at UC San Diego sought to remove these roadblocks to conductivity by replacing semiconductors with free electrons in space. "And we wanted to do this at the microscale," said a researcher. However, liberating electrons from materials is challenging. It either requires applying high voltages (at least 100 Volts), high power lasers or extremely high temperatures (more than 1,000 degrees Fahrenheit), which aren't practical in micro- and nanoscale electronic devices. To address this challenge, the research team fabricated a microscale device that can release electrons from a material without such extreme requirements. The device consists of an engineered surface, called a metasurface, on top of a silicon wafer, with a layer of silicon dioxide in between. The metasurface consists of an array of gold mushroom-like nanostructures on an array of parallel gold strips. The gold metasurface is designed such that when a low DC voltage (under 10 Volts) and a low power infrared laser are both applied, the metasurface generates "hot spots" -- spots with a high intensity electric field -- that provide enough energy to pull electrons out from the metal and liberate them into space. Tests on the device showed a 1,000 percent change in conductivity. "That means more available electrons for manipulation," researchers said. "This certainly won't replace all semiconductor devices, but it may be the best approach for certain specialty applications, such as very high frequencies or high power devices," a researcher said. According to researchers, this particular metasurface was designed as a proof-of-concept. Different metasurfaces will need to be designed and optimized for different types of microelectronic devices. "Next we need to understand how far these devices can be scaled and the limits of their performance," researchers said. The team is also exploring other applications for this technology besides electronics, such as photochemistry, photocatalysis, enabling new kinds of photovoltaic devices or environmental applications.

Source https://www.sciencedaily.com/releases/2016/11/161108115009.htm

Aerospace Engineering

7. 'Morphing' Wing Offers New Twist on Plane Flight and Manufacturing

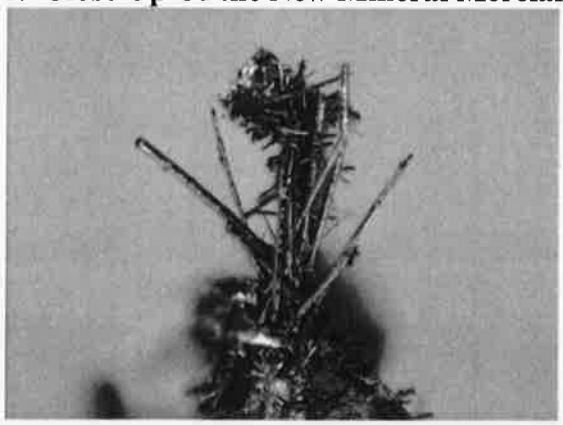


A Newly developed wing architecture could greatly simplify the manufacturing process and reduce fuel consumption by improving the wing's aerodynamics. It is based on a system of tiny, lightweight subunits that could be assembled by a team of small specialized robots, and could ultimately be used to build the entire airframe.

When the Wright brothers accomplished their first powered flight more than a century ago, they controlled the motion of their Flyer 1 aircraft using wires and pulleys that bent and twisted the wood-and-canvas wings. This system was quite different than the separate, hinged flaps and ailerons that have performed those functions on most aircraft ever since. As a result of research by engineers at MIT and NASA, some aircraft may be returning to their roots, with a new kind of bendable, "morphing" wing. The new wing architecture, which could greatly simplify the manufacturing process and reduce fuel consumption by improving the wing's aerodynamics, as well as improving its agility, is based on a system of tiny, lightweight subunits that could be assembled by a team of small specialized robots, and ultimately could be used to build the entire airframe. The wing would be covered by a "skin" made of overlapping pieces that might resemble scales or feathers. The whole shape of the wing can be changed, and twisted uniformly along its length, by activating two small motors that apply a twisting pressure to each wingtip. The basic principle behind the new concept is the use of an array of tiny, lightweight structural pieces, which researcher Gershenfeld calls "digital materials," that can be assembled into a virtually infinite variety of shapes. The assembly could be done by simple miniature robots that would crawl along or inside the structure as it took shape. The team has already developed prototypes of such robots. The individual pieces are strong and stiff, but the exact choice of the dimensions and materials used for the pieces, and the geometry of how they are assembled, allow for a precise tuning of the flexibility of the final shape. For the initial test structure, the goal was to allow the wing to twist in a precise way that would substitute for the motion of separate structural pieces while providing a single, smooth aerodynamic surface. Building up a large and complex structure from an array of small, identical building blocks, which have an exceptional combination of strength, light weight, and flexibility, greatly simplifies the manufacturing process, Gershenfeld explains. While the construction of light composite wings for today's aircraft requires large, specialized equipment for layering and hardening the material, the new modular structures could be rapidly manufactured in mass quantities and then assembled robotically in place. This research "presents a general strategy for increasing the performance of highly compliant -- that is, 'soft' -- robots and mechanisms," by replacing conventional flexible materials with new cellular materials "that are much lower weight, more tunable, and can be made to dissipate energy at much lower rates" while having equivalent stiffness. The team consulted with NASA engineers and others seeking ways to improve the efficiency of aircraft manufacturing and flight. They learned that "the idea that you could continuously deform a wing shape to do pure lift and roll has been a holy grail in the field, for both efficiency and agility," they say. Given the importance of fuel costs in both the economics of the airline industry and that sector's contribution to greenhouse gas emissions, even small improvements in fuel efficiency could have a significant impact. Wind-tunnel tests of this structure showed that it at least matches the aerodynamic properties of a conventional wing, at about one-tenth the weight. The "skin" of the wing also enhances the structure's performance. It's made from overlapping strips of flexible material, layered somewhat like feathers or fish scales, allowing for the pieces to move across each other as the wing flexes, while still providing a smooth outer surface. The modular structure also provides greater ease of both assembly and disassembly: One of this system's big advantages, in principle, the researcher says, is that when it's no longer needed, the whole structure can be taken apart into its component parts, which can then be reassembled. Similarly, repairs could be made by simply replacing an area of damaged subunits. "An inspection robot could just find where the broken part is and replace it, and keep the aircraft 100 percent healthy at all times," he says. Following up on the successful wind tunnel tests, the team is now extending the work to tests of a flyable unpiloted aircraft, and initial tests have shown great promise, he says. "

Source https://www.sciencedaily.com/releases/2016/11/161103123816.htm

8. Close Up Of the New Mineral Merelaniite

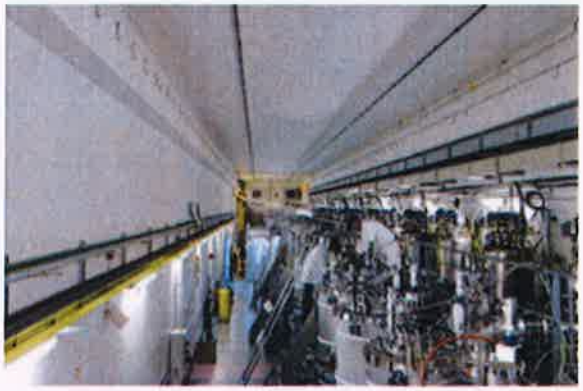


The tiny, silvery, cylindrical whiskers are a new mineral—merelaniite—named for a mining region in Tanzania.

In the age of fast-paced global communication, it's no wonder that the anatomy of the new mineral merelaniite took a team from around the world. Most mineral discoveries start with boots on the ground -- or, rather, below the ground. The Merelani mining district is a well-known locale. Not only for prized tanzanite and tsavorite used in jewellery, but also for hosting a suite of other minerals increasingly prized by mineral collectors."The Merelani district has been famous since the late 1960s for the blue gem variety of zoisite known as tanzanite, but this is really a mineral collector's paradise and an exciting place to look for new minerals," says John Jaszczak, a physics professor at Michigan Tech. "The importance of the area is the reason we wanted to give tribute to the miners and name merelaniite for the district." There are 5,179 minerals listed by the International Mineralogical Association and their Commission on New Minerals, Nomenclature and Classification (CNMNC) receive more than 80 proposals each year for new ones. Many turn out to be variations of existing minerals. To discern the new from the variable, Jaszzak and his team put the tiny merelaniite whiskers through a battery of rigorous tests, particularly to discern its chemistry and crystal structure. "It is one thing to find a mineral that is probably new, it is quite another thing to be able to perform all of the required analyses to satisfy the CNMNC for approval of its status and a new name," Jaszczak says. He teamed up with experts at the Natural History Museum in London to determine the chemical composition of the new mineral with precision. To help with understanding the crystal structure, Steve Hackney, professor of materials science at Michigan Tech, was able to provide crucial high-resolution images and diffraction patterns using transmission electron microscopy on ultrathin samples prepared with a diamond knife by Owen Mills, director of Michigan Tech's Applied Chemical & Morphological Analysis Laboratory. The growing team then sought out the help of Luca Bindi, a professor at the Università di Firenze in Italy and an expert in solving complicated crystals structures. He helped run x-ray diffraction studies to put all of the pieces together. The results revealed a complex structure made up of layers of molybdenum disulfide alternating at the atomic scale with layers of lead sulfide, along with other elements, including vanadium, antimony, bismuth, and selenium. The layers curve inward, growing into a scroll-like cylinder. Although it is not a showcase gem, merelaniite is attractive, and as the analyses show, it has an intricate, microscopic internal beauty as well. A better understanding of the crystal chemistry of these exotic materials may eventually find useful applications. Echoing physicist Richard Feynman, Jaszczak notes, "Science is about taking pleasure in finding things out and we're delighted to have uncovered and described this beautiful new mineral."

Source https://www.sciencedaily.com/releases/2016/10/161029124425.htm

9. New SPIRAL2 Particle Accelerator in France



View of SPIRAL2's LINAC (LINear ACcelerator), with its superconducting cryomodules containing acceleration cavities.

The new SPIRAL2 particle accelerator at the French large heavy-ion accelerator GANIL (CNRS/CEA), inaugurated last month will be able to produce immensely powerful particle beams, enabling scientists to push back the frontiers of knowledge. This will double France's experimental capability in nuclear physics, especially with regard to research into atomic nuclei and the mechanisms of nuclear reactions, such as those that take place within stars. Initial experiments are expected to get underway in mid 2017. Studying atomic nuclei is of fundamental importance since they contain nearly the entire mass of the atoms of which all matter is made. The SPIRAL2 facility will be used to probe the very heart of matter. It is designed to produce huge quantities of 'exotic' particles, making it possible to carry out novel experiments in nuclear physics and astrophysics. Multidisciplinary applied research will also be carried out at SPIRAL2 in the fields of health care (radiotherapy, diagnosis and biomedical research), materials for microfiltration (membranes for the agri-food and health sectors), electronics, the aerospace industry, and nuclear fission and fusion. SPIRAL2 is one of the world's six most important research projects in nuclear physics. Construction of SPIRAL2 began in 2011. Its design and construction involved a large number of public research laboratories (in particular from the CEA and CNRS) as well as high-tech companies both in France and Europe. Set up in 1976 by the CEA and CNRS, GANIL is the French large heavy-ion accelerator. In nuclear physics, it has already led to numerous discoveries about the structure of atomic nuclei and their thermal and mechanical properties, as well as about exotic nuclei, so called because they do not exist in the natural state.

Source https://www.sciencedaily.com/releases/2016/11/161103115159.htm

Interdisciplinary Engineering and Special Fields

10. Researchers Bring Eyewear-Free 3-D Capabilities to Small Screen

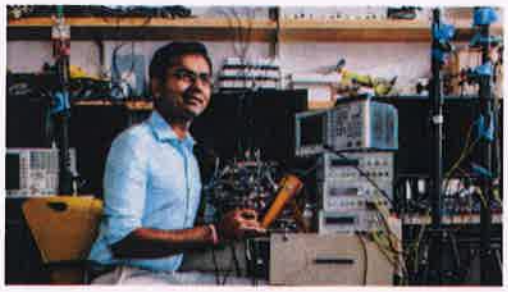
Convertible video displays that offer both 2D and 3D imaging without the need of any eyewear offer greater convenience to users who would otherwise have to keep track of yet another accessory. Such autostereoscopic displays have already hit the TV market, but the underlying technology reveals its limitations at close viewing distances. Viewers typically must view these displays from a distance of around one meter eliminating any practical applicability to the smaller screens of mobile devices. Researchers at Seoul National University, South Korea, however, have developed a new method of making these convertible displays that not only achieved near-viewing capabilities, but also simplified and shrank the architecture of the technology. For eyewear-free displays, the only action is behind the screen where the images' pixels and optics are layered together to produce the stereoscopic effect. The two primary ways of producing these optically illusive effects are by using either an array of micro-lenses, called lenticular lenses, or an array of micro-filters, called parallax barriers, in front of the image to make its appearance depend on the angle at which it is being seen.The simplest example of this effect is found on a movie poster whose image appears to change as you walk by. Two (or more) images are interlaced and printed behind a plastic layer with grooves matching the interlaced pattern. The grooves act as distinct, interlaced arrays of lenses or filters, revealing one image as you approach the poster and another as you depart, viewing the same poster from a different angle. In the case of 2D/3D convertible screens, these layers are active, meaning they can be electronically switched on or off. The gap distance between the image layer and the barrier layer is a key determinant of the viewing distance. Closer stacking of these layers together allows for a closer viewing distance. Sin-Doo Lee, a professor of electrical engineering at Seoul National University, and his colleagues describe a monolithic structure that effectively combines the active parallax barrier, a polarizing sheet and an image layer into a single panel. Instead of two separate image and barrier panels, they use a polarizing interlayer with the image layer in direct contact with one side of the interlayer, while the active parallax barrier of a liquid crystal layer is formed on the other side as an array of periodically patterned indium-tin-oxide (ITO) electrodes.The use of this interlayer allows the minimum separation of the image and barrier layers, thus providing the short viewing distance required for the smaller screens of mobile devices. "The polarizing interlayer approach here will allow high resolution together with design flexibility of the displays, and will be applicable for fabricating other types of displays such as viewing-angle switchable devices," Lee said. "Our technology will definitely benefit display companies in manufacturing low cost and light weight 2D/3D convertible displays for mobile applications. Under mobile environments, the weight is one of the important factors." This concept not only applies to LC-based 2D/3D displays, but also to OLED-based 2D/3D displays, offering application to a broad range of present and future device designs.

Source https://www.sciencedaily.com/releases/2016/10/161031113245.htm

Engineering Innovation in India

MIT Technology Review 35 Innovators under 35 2016

The people in the MIT Technology Review 16th annual celebration of young innovators are disrupters and dreamers. They're inquisitive and persistent, inspired and inspiring. No matter whether they're pursuing medical breakthroughs, refashioning energy technologies, making computers more useful, or engineering cooler electronic devices—and regardless of whether they are heading startups, working in big companies, or doing research in academic labs—they all are poised to be leaders in their fields. Dinesh Bharadia, 28 is one of the Indian origin scientists honoured as a young innovator.



Dinesh Bharadia, MIT Computer Science and Artificial Intelligence Laboratory

A seemingly impossible radio design will double wireless data capabilities. -Dinesh Bharadia invented a telecommunications technology that everyone said would never work: he found a way to simultaneously transmit and receive data on the same frequency. Because the signal from broadcasting a radio transmission can be 100 billion times louder than the receiving one, it was always assumed that outgoing signals would invariably drown out incoming ones. That's why radios typically send and receive on different frequencies or rapidly alternate between transmitting and receiving. "Even textbooks kind of assumed it was impossible," Bharadia says. Bharadia developed hardware and software that selectively cancel the far louder outgoing transmission so that a radio can decipher the incoming message. The creation of the first full-duplex radio, which eventually could be incorporated into cell phones, should effectively double available wireless bandwidth by simply using it twice. That would be a godsend for telecom companies and consumers alike. Bharadia took a leave of absence from his PhD studies at Stanford so he could commercialize the radio through the startup Kumu Networks. Germany-based Deutsche Telekom began testing it last year, but since Bharadia's prototype circuit board is too large to fit in a phone, it will be up to other engineers to miniaturize it.

Source https://www.technologyreview.com/lists/innovators-under-35/2016/?utm_campaign=internal&utm_medium=homepage&utm_source=features_2