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Delegation from University of York, UK at FITT

Delegation from Medtronic at FITT

Transfer of IITD Fabric Field Tester, IP and knowhow to Texlab Industries, Ahmedabad

Dr. Sheldon Levy, President & Vice Chancellor, Ryerson University, Canada at IIT Delhi

Participants at International Course on Transportation Planning, Road Safety & Biomechanics, IIT Delhi

CONTENT

Ed...

Innovation, Inflation, Corruption,..... the good, bad and ugly respectively, were as prominent during the past year as *Kolaveri Di !* Of the three, while inflation can be tamed corruption needs to be hounded out and it is innovation which, as a very desirable proposition, ought to become a way of life – an evergreen song, perhaps! Interestingly, innovation seems to be the mantra often cited to address all the challenges around us. The worry, however, is whether innovation is well understood and applied. The moorings of the innovation culture have to be deep-rooted and sustained. It ought not to become another catch word that will float for some time before we take fancy for something else! Importantly, people as consumers/users of innovation shall, at the end of the day, try to see the benefits that have been generated. New/breakthrough technologies, though always great news, may not happen with regular frequency. Innovation should, at least, create additional value and incrementally better our existing products and services. Also, we should not talk of innovation in vacuum. Innovation is tangible, ever evolving and should manifest in sustainable solutions and products and make our life and environment better.

While I write this, it is a very good feeling to report the inauguration (on Jan 6'12) of Hydrogen 3-wheelers at Pragati Maidan in N Delhi. This is an outcome of a few years' consortium effort (DelHy3W) of IIT Delhi, UNIDO, Mahindra, Air Products and the Government entities; a commendable joint effort towards sustainable energy scenario. As the industry interface of IIT Delhi, FITT constantly explores value accretive partnerships and supplements the Institute efforts towards external engagement. Actualization of a larger body of academic research resultants would be a huge boost to efforts by organisations like us towards unlocking the value of such a knowledge base. It is somewhere in this knowledge mass that we may find those elusive billion dollar ideas!

Anil Wali

INVITED ARTICLES

Lithium-ion Batteries: From Portable Electronics to Drive Trains

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In recent years, the successful development and implementation of high-energy Li-ion batteries has allowed for their use in a variety of portable devices. Table 1 shows the cell potential and energy metrics for some of the past and present battery technologies, through which it can be inferred that Li-based batteries offer higher gravimetric and volumetric energy densities, in addition to higher specific power. Moreover, Li-ion batteries are less toxic as compared to lead-acid or Ni-Cd, and disposing them is less hazardous to the environment. Due to their light weight design (because Lithium is the most electropositive and the lightest metal) and reversible characteristics, Li-based batteries have become a rapidly evolving field of research for energy storage applications.

Although Li-ion offers considerable improvements over the conventional rechargeable batteries, it has its share of disadvantages as well. Li-metal based technologies can be challenging to implement due to the irreversibility that could manifest as a result of Lithium reacting with the electrolyte. Such a problem could be solved by the formation of a protective film on the surface of the electrodes. The film inhibits the reactions at the surface between the Li-electrode and the electrolyte, but impacts the maximum capacity that can be extracted from the cell. An alternative has been realized in which the Li-metal electrode is replaced with Li-based compounds, such as LiC_6, which further stabilize the solid-electrolyte interface. The formation of dendrites on the Li-metal and electrolyte interface is also exterminated by the use of Li-ion electrodes instead of Li-metal. An illustration of such a cell is shown in Fig.1.[1] To attain longer cycle life and highly reversible reactions, electrodes need to be manufactured out of materials that can enable a faster transfer of ions from one electrode to another. Commonly found transition metal oxides, such as MnO_2, CoO_2 etc., offer significant advantages due to their layered structure (which enables the ions to reside in interstitial sites) and no bond breakage while the intercalation-deintercalation processes. Another alternative to resolve the stability issues as a result of reactions occurring at the electrode-electrolyte interface is to replace the liquid electrolyte with a polymeric substance.

Table 1: Comparison of different battery technologies

Type	Cell Voltage	Energy Density		Power	Life
	(V)	(W-h/kg)	(W-h/L)	(W/kg)	(Cycles)
Lead-acid	2.1	~30	~60	~200	~600
Ni-Cd	1.2	~50	~100	~150	~1500
NiMH	1.2	~50	~220	~500	~1000
Li-ion	3.6	~150	~250	~1800	~1000
Li-polymer	3.7	~170	~300	~3000	~750
$LiFePO_4$	3.25	~100	~170	~1500	~2000

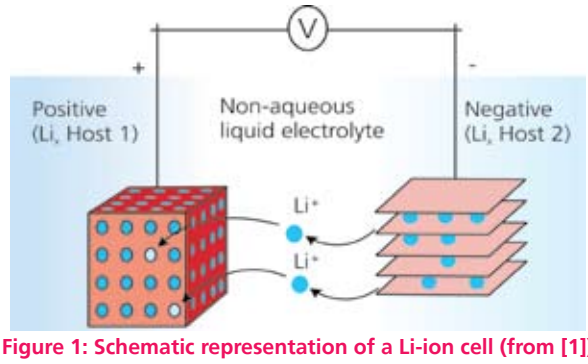

Figure 1: Schematic representation of a Li-ion cell (from [1])

Even after these developments, however, the extension of Li-ion batteries, from portable electronics to hybrid and electric vehicles, is significant.[2] Typically, optimizing the design and performance of a battery-pack begins from the material to the coin cell level. However, this process can be expensive, both in time and monetary terms, since a design that may be optimum at the cell level may not be the best choice at the pack-scale. Developing a better understanding of the role of material properties and manipulating the morphology of the particle clusters comprising Li-ion electrodes could lead to potential opportunities for attaining higher performance goals, for which the effect of both material properties and morphology needs to be considered in a physics-based model. Recent work has also shown that performance of Li-ion technology can be improved through emphasis on engineering the microstructural architecture of battery electrodes.[3, 4, 5] In this effect, the key feature highlighted in this article is a multiscale model to interrogate cell performance at disparate length scales through the calculation of effective transport properties (such as conductivity, diffusivity etc.) and Li-ion reaction density at the particle-electrolyte interface (microscale) and their subsequent use in cell (macroscale) analysis.

Multi-scale Modeling Framework

In Li-ion cells, the discharge and electrochemical insertion/removal processes occur at scales that are different by orders of magnitude. Successful modeling of cell physics is only possible if the selected grid resolution can at least capture the microscale reactions occurring at the particle-electrolyte interface. However, such direct simulation would be impractical, as present day computers do not have the power and capability to handle a mesh that may consist of $O(10^{10})$ discrete points based on resolving every single particle in the electrode. An alternative approach is to develop a micro-macro model by creating an intermediate scale which may represent the physics when scales much smaller than the computational mesh are employed. One such option is to include the effect of the microstructure in a macroscopic model through the volume averaging technique.

This article presents the extension of an earlier multiscale modeling effort[6] by analyzing the electrochemical processes at the particle-scale in the cathode of a Li-ion cell. Since microscopic models for analysis are accurate but computationally expensive, and macroscopic models are simplified but efficient, volume averaging[7] has been used as a bridge between the two alternatives. In addition, surrogate tools have been employed to identify the reduced-order relationships between microscopic simulations and the closure terms of the volume-averaged equations. Surrogate modeling is concerned with the determination of a continuous function of a set of independent variables from a limited amount of data.[8] In other words, it can be employed to correlate design variables of a mathematical or experimental set-up with the outcomes (or objective functions) of the design process. The surrogate models constructed in such a manner can be used for fast prediction and evaluation of the design problem. In the current multiscale modeling framework being developed, surrogate models constructed on numerical simulations used to calculate the closure terms and effective transport properties provide an opportunity to combine the physics at various scales in a computationally efficient manner.

In this work, the focus has been on the calculation of closure terms and effective material properties that appear in the volume-averaged equations using microscopic scale simulations based on a cluster of particles enclosed in a representative elementary volume (REV). The solid phase was assumed to be composed of 10$LiMn_2O_4$ ellipsoidal particles of aspect ratio 2. These uniform-sized particles were arranged using a molecular dynamics based packing algorithm[9] for an initial volume fraction of the solid phase of 0.6. The void space surrounding the particle cluster was prescribed as the electrolyte phase, chosen to be $LiPF_6$ in EC:DMC. As part of the construction of surrogate models, approximately 10^4 simulations were conducted.

Steady state concentration profiles for the maximum and minimum effective solid diffusion coefficients obtained in the simulations are also shown in Fig. 2. The current numerical simulations indicate the strong influence of the packing arrangement, and hence tortuosity, and a higher resistance to conduction of Li-ions and charge inside the solid, an aspect not captured by the empirical correlations. Fig. 2(a) reveals a variation in concentration which is near uniform at each cross-section. Fig. 2(b) shows a larger pocket of solid which does not take part in the conduction process, indicating that using empirical models, such as Bruggeman's equation, in a macroscale simulation to characterize the packing of particles may not be accurate.

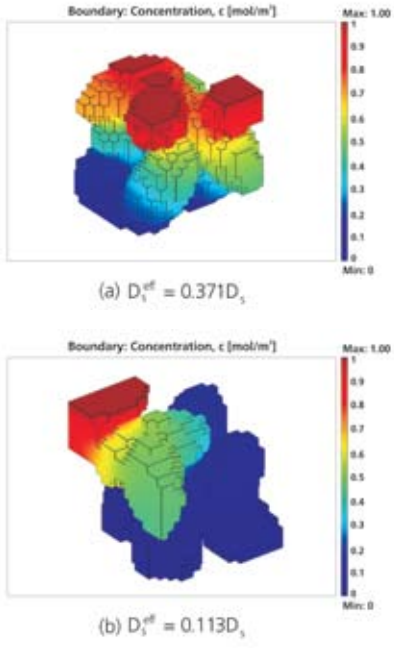

Figure 2: Concentration profiles in two contrasting cases for effective property calculation

The predictions from the microscale simulations for different particle clusters were also compared with the pseudo-2D cell model which is based on porous-electrode and concentrated solution theories.[10] Cell simulations were run for a discharge rate of 1C to record the macroscopic time variation of concentrations and electric potentials in the two phases. The microscale variation of reaction density at the interface was analyzed at a location which was fixed at 25μm from the separator. The local reaction density at the solid-electrolyte interface for a particular microstructure at selected time instants is shown in Fig. 3. The flux at the solid-electrolyte interface depends on the concentration in the two phases and the surface over-potential. Figure 3 reveals two features of reaction density distribution at the microscale. First, the magnitude of local reaction density at t=60 and 2400 sec. is predominantly lower than that for t=600 sec. Although the presence of high reaction density regions is noticed for t=2400 sec., these are fairly local and confined. As a result, the integrated reaction density at either t=60 sec. or 2400 sec. is very different from that at t=600 sec. Second, the magnitude of Li-ion flux into the solid was observed to be highest in regions where the state of charge is lowest (not shown here). The varying form of the reaction density reveals that destabilizing side reactions, which get accelerated at high discharge rates, will play a key role when designing batteries for automotive applications which inherently require high rates of charge and discharge.

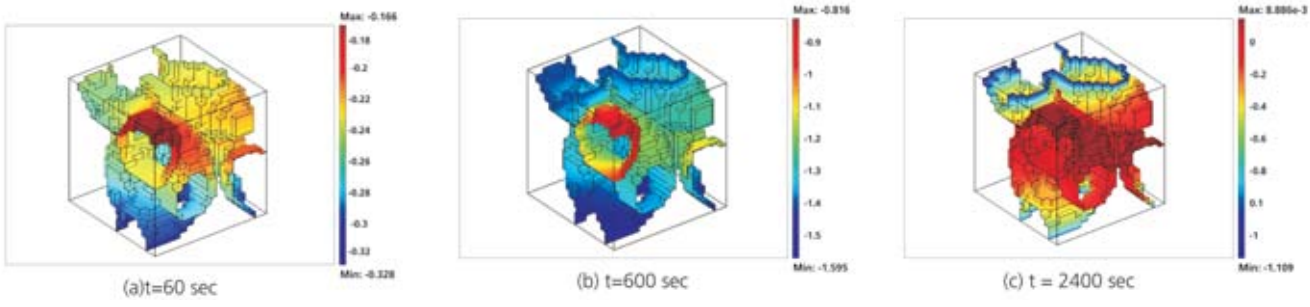

Figure 3: Normalized reaction density (in A/m²) at different time instants for 1C discharge rate

Conclusions

In this short paper, a review of the current status of Li-ion based energy storage devices has been presented in context of high discharge rate demanding hybrid/electric vehicles. The focus of is on advancing the lifespan of Li-ion based technologies by including microstructural details of electrodes in a multiscale modeling framework to accurately predict physiochemical processes at disparate length and time scales.

So far, particle cluster simulations indicate the limitations associated with the use of empirical correlations in macroscale simulations as these may under or over-predict the transport processes occurring inside a Li-ion cell. The present study offers a first-step towards integration of the effect of microstructure into a macroscale simulation through the calculation of effective transport and closure terms. These closure terms derived from the particle-cluster simulations could be incorporated into a macroscopic model to gain fast-prediction of battery performance. The long-term objective is to employ such a framework to obtain a mathematical model to predict 'cell health' as a function of 'control' variables to predict cell aging, degradation aspects and performance for applications such as hybrid/electric vehicles.

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Enzyme Catalyzed Synthesis of Polyesters

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For production of synthetic polymers, the need to develop environment-friendly processes and products has always motivated polymer chemists to look for alternative routes of polymerization. Taking specifically the case from family of polyesters, the use of conventional organo-metallic catalysts for polyester synthesis has until now enabled the generation of important commercial products via different synthetic routes such as polycondensation or ring-opening polymerization. Aromatic polyester e.g. PET [Poly(ethylene terephthalate)] is one commercially successful polyester primarily synthesized by polycondensation route and used as fibers, films and blown bottles. PLA [Poly(L-lactide)] and PCL [poly(ε-caprolactone)] are aliphatic polyesters which are synthesized via ring-opening polymerization and are of high academic as well as industrial research interest due to their biodegradable properties. The catalysts used hitherto to perform such poly-condensation or ring-opening polymerizations are based on derivatives of heavy metals such as Zn, Co, Mg, Al, Sn or Ge which is difficult to remove after polymerization is over and can cause undesirable effects on the environment upon disposal. This is also of concern if the polymers (e.g. PLA or PCL) are intended to be used for tissue engineering applications as the toxic metallic impurities from catalyst may become concentrated within matrix remnants and result in fatal situations in long run. The other undesirable characteristics of chemically catalyzed polymerizations include the need to conduct reactions at high temperatures (poly-condensation generally at 150–280°C) with organo-metallic catalysts that are not only toxic but also lack selectivity. The use of such catalysts may also limit the synthesis of polyesters having more complex and well-defined macromolecular architecture.

The technique of *in-vitro* enzyme catalysis is one of the most promising alternatives to synthesize aliphatic or aromatic polyesters avoiding the use of organo-metallic catalysts. The use of enzymes for *in-vitro* polyester synthesis has been actively pursued in the last decade. Unlike organo-metallic catalysts, enzymes catalyzes the polymerization under mild conditions (e.g. temperature ≤ 100°C), avoids the introduction of heavy metals to polymer and offers selectivity that circumvent protection-deprotection steps during synthesis. The "Key-and-Lock" mechanism, proposed by Emil Fisher more than 100 years ago, for specific substrate selectivity by enzyme is based on molecular recognition of the substrate by enzyme through supramolecular interactions. This is not only true for all the *in-vivo* enzymatic reactions but also for *in-vitro* reactions, however the substrate-enzyme association under *in-vitro* condition is found to be not as strict as the key-and-lock mechanism. This becomes possible as enzymes are dynamic and sometimes very generous in recognizing even unnatural substrates *in-vitro,* which allows enzymes to catalyze synthesis of diverse synthetic polymers. Enzymatic polymerization is defined as in-vitro polymerization catalyzed by an isolated enzyme and research is ongoing to synthesize a variety of polymers including polyesters, polycarbonates, polyaromatics and polyvinyls using this technique. The enzymatic polymerization is regarded as an environment-friendly synthetic process for polymeric materials, providing a good example of synthetic approach based on "green polymer chemistry". The benefits of enzyme-catalyzed polymerization are:

- Enzymes are potential substitute for toxic heavy metal catalysts currently used in the synthesis of polymer
- Enzymes are derived from renewable resources and can be easily separated from the synthesized polymers
- Enzymes can be used in bulk, organic media and at various interfaces and in most cases are recyclable after polymerization which reduces the cost of catalyst
- Enzyme-catalyzed polymerizations occur under mild conditions i.e. temperature, pressure and pH etc. with high enantio- and regio-selectivity
- Polymers with well-defined structures can be formed by enzyme-catalyzed processes. Steric hindrance at active site of enzyme enables the synthesis of linear or nearly linear polymer chains even when monomers with functionality ≥ 3 are used.

Lipases, the ubiquitous enzymes, have been found in most organisms from microbial, plant and animal kingdom and they are the most versatile class of enzymes that have been explored to synthesize polyesters. Lipases are esterases which catalyze the hydrolysis of fatty acid esters normally in aqueous environment in living systems. However, the hydrolysis (or chemical bond breakage) catalyzed by lipases in aqueous media can be easily reversed in non-aqueous media to carry out the ester synthesis (i.e. chemical bond formation). Some lipases are explored for this purpose to perform *in-vitro* esterification and trans-esterification reactions due to the fact that, in contrast to most other enzymes, they are stable in organic solvents and accept a broad range of substrates. All lipases show a significant structural and functional similarity regardless of the difference in their molecular mass and the organism from which they are isolated. A unique structural feature common to most lipases is a lid or flap made of amphiphilic α-helix peptide sequence which in its closed conformation prevents access of the substrate to the active site of the enzyme. The active site

is composed of a nucleophilic serine (Ser) residue activated by hydrogen bond with histidine (His) and aspartate (Asp) or glutamate (Glu). Once the lid is opened, a large hydrophobic surface is created to which the hydrophobic substrate (monomer) binds. This specific stability and activity of lipases has been used to produce polyesters by both ring-opening polymerization as well as poly-condensation routes.

Lipase-catalyzed ring-opening polymerization of lactones was first presented by two independent groups, Kobayashi et al. and Knani et al. in 1993 and the technique has rapidly developed as a novel methodology for polyester synthesis since then. In addition to advantages mentioned already, lipases do not require the exclusion of water and air when used as catalysts for polyester synthesis. This is in contrast to the use of traditional organo-metallic catalysts where strict precautions must be taken to exclude air and water from the system. Small (4–7 member) cyclic lactones have ring strains and are easily polymerized by organo-metallic catalysts, but the polymerization of large ring lactones (macrolides) is slow and only low molecular weight products are obtained. Lipases have shown the capability to polymerize macrolides under normal polymerization conditions. The most researched lipase that has been used to synthesize polyesters is a physically immobilized form of *Candida antarctica* known commercially as Novozyme-435. Lactones, lactides and cyclic carbonates of ring-size from 4 to 17 have been polymerized in several laboratories using lipases from various sources aiming to produce high molecular weight polymers. A short summary of results obtained are presented in Table 1.

Table 1: Examples of polyesters synthesized via lipase catalyzed ring-opening polymerization

Monomer*	Lipase**	Temp (°C)	Time (h)	Medium	M_n (g/mol)	M_w (g/mol)	Conversion (%)
ß-PL	CC	60	48	Bulk		49100	99
ß-BL	PS	45	480	Bulk	7700		85
δ-VL	PHB-Af	80	48	Bulk	2500	3700	90
1,5-DXO	N435	60	4	Bulk	56000		97
CL	N435	60	4	Bulk	22000	31000	47
CL	N435	65	24	scCO2	35000	54000	98
OL	PC	75	240	Isooctane	16000	22000	85
UDL	CC	75	240	Bulk	25200		95
DDL	i-PS	75	120	Bulk	25000		100
PDL	CA	70	4	Toluene	64500		93
HDL	PC	75	120	Bulk	5800		100
LLA	PS	100	168	Bulk		48000	82
TMC	PPL	100	24	Bulk		169000	96

***Monomers - β-PL:** β-propiolactone, **β-BL:** β-butyrolactone, **δ-VL:** δ-valerolactone, **1,5-DXO:** 1,5 dioxepan-2-one, **CL:** ε-caprolactone, **OL:** 8-octanolide, **UDL:** 11-undecanolide, **DDL:** 12-dodecanolide, **PDL:** 15-pentadecanolide, **HDL:** 16-hexadecanolide, **LLA:** L-lactide, **TMC:** trimethylene carbonate ****Lipases - CC:** Candida cylindracea, **PSL:** Pseudomonas species, **PHB-Af:** PHB depolymerase from Alcaligenes faecalis, **N435** or **CA:** Novozyme 435 (Candida antarctica), **PC:** Pseudomonas cepacia, **i-PS:** immobilized PS, **PPL:** Porcine pancreatic lipase

For polyester synthesis via enzyme-catalyzed polycondensation route, it is generally considered that activation of carboxylic acids by electron withdrawing groups is required to carry out polymerization with diols or polyols. However, with the use of lipase-catalyzed polycondensations, the requirement for activation of carboxylic acids can be prevented. Lipase-catalyzed polycondensations are useful for a broad range of substrates, such that many dicarboxylic acids (and their derivatives), glycols, and oxyacids (and their esters) are suitable monomers. In addition, some research groups have reported a significant decrease in polymerization time from days to hours. Another example of the versatility of lipase-catalyzed polyester synthesis is their ability to concurrently catalyze ring-opening polymerization and polycondensation. Some examples of lipase-catalyzed polycondensations are presented in Table 2.

Table 2: Examples of polyesters synthesized via lipase-catalyzed poly-condensation reactions

Monomer*	Lipase**	Temp. (°C)	Time (h)	Medium	M_n (g/mol)	M_w (g/mol)	Yield (%)
AA, OD, glycerol	N435	70	42	Bulk		75600	90
TMP, OD, AA	N435	70	42	Bulk		26100	94
HD, DMM	N435	70	24	Bulk		16300	92
PEG-1500, DMAIP	N435	90	48	Bulk	23000		93
12- and 16-C ω-hydroxyacids	N435	90	4	Bulk	23000		
AA, OD	N435	70	8	Bulk	15000		
PDL, DVS, BD	PC	60	72	Isopropyl ether	6500		80

***Monomers - AA:** adipic acid, **OD:** 1,8-octanediol, **TMP:** trimethylolpropane, **HD:** 1,6-hexanediol, **DMM:** dimethyl malate, **PEG:** polyethylene glycol, **DMAIP:** dimethyl 5-aminoisophthalate, **PDL:** 15-pentadecanolide, **DVS:** divinyl sebacate, **BD:** 1,4-butanediol; ****Lipases- N435:** Novozyme 435, **PC:** Pseudomonas cepacia

An exponential growth in research that has been observed in the last decade to exploit enzymes for polymerization of different monomers is due to the fact that enzymes are non-toxic substitutes to traditional organo-metallic catalyst. Aliphatic polyesters e.g. PLA or PCL synthesized using enzyme-catalyzed polymerizations are shown to have better cell adhesion and growth than those polyesters synthesized using organo-metallic catalysts. Furthermore, enzymes catalyze polymerizations under mild conditions, maintain high enantio- and regio- selectivity, can be easily separated from the synthesized polymer and are in most cases recyclable. However, the drawbacks of using enzymes, as compared to organo-metallic catalysts, are the higher cost, large quantity required to obtain the same yield and formation of relatively low molecular weight polymers. For polycondensation at high temperature, high melting monomers and polymers are polymerized where decreased diffusion constraints are obtained during chain growth due to reduced viscosity of the reaction mixture. The current lack of enzymes having adequate stability at temperatures >100°C exclude their use for high melting monomers or polymers under bulk reaction conditions (e.g. PET, which melts at 270°C). Due to these reasons, the technique of *in-vitro* enzyme-catalyzed polymerization is still at the stage of infancy and obstructed for employment at industrial level. Some remedial actions are required to help this technique grow. Enzymes having increased activity should be developed so that the amount of catalyst required performing a polymerization can be reduced. Typically enzymes are used in amounts of 5-10 wt% of monomers in standard polycondensation or ring-opening polymerization recipes and an attainable target would be to reduce enzyme concentration by < 0.1 wt%. This can be one of the several approaches to reduce overall cost of using enzymes in place of organo-metallic catalysts. Furthermore, improved thermal stability of enzymes will facilitate conducting enzyme-catalyzed poly-condensations at temperatures well above 100°C.

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Field Emission Display (FED) – An Emerging Technology

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The present days display technology suitable for large-scale (wallpaper) domestic use, demands following requirements: i. Efficient energy use, ii. Flexibility, iii. Performance – brightness, color accuracy, contrast etc.

Technologies currently in the market are: (i) Cathode ray tube (CRT), (ii) Liquid crystal display (LCD), (iii) Plasma display and (iv) Light emitting diode based display.

Although having capability of depicting sharp dynamic color images incorporating details of graphics and texts, CRT suffers from its bulkiness. Three electron guns (in case of a color CRT) reside behind the face plate ensuring the raster of electron beams across each phosphor (red, blue and green) containing pixel to generate the image, demands a more compact display modules. Standard LCD construction is basically a sandwich of transistors, liquid crystals, and color filters between two pieces of polarized glass, which are oriented at 90 degrees to each other. The active part of the display is the liquid crystal layer; each crystal's orientation is controlled by a transistor (transistors, in some cases). Because of their manufacturing complexity, their fragility (two glass layers) and finally because they rely on emissive display, LCD seems not capable to capture market for a long time. Gas plasma displays work much the same way LCD's do, but instead of liquid crystals passing light through a colored filter, they contain noble gasses that emit ultraviolet light when excited by the transistors that in turn makes some phosphors glow red, green, or blue, creating pixels. However, it suffers from colour contrast problem and has the similar drawbacks as LCDs. LED based displays are flexible, chip, highly efficient and has a strong promise for future technology. The only drawback is that they still depend on emitting light to create an image, making them impractical in daylight or other brightly lit environments.

The FED, which relies on a back plane of many microscopic/nanoscopic electron guns provide electrons which can directly impinge on the nearby phosphor anode is the closest to the CRT technology and promising way to thin down the bulky CRT displays. Although the architecture in FED is a natural extension of CRT, sounds relatively simpler and technologically feasible, the hurdles come from proper synthesis and engineering of such nanoscale emitters. The power requirement is also less in case of FEDs.
A typical field emission display structure is depicted below:

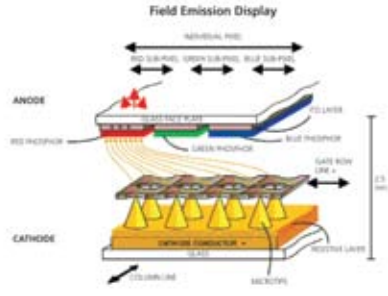


Figure 1: Typical geometry of FED display

(source: http://www.vrarchitect.net/anu/cg/Display/Image/feddiagram.gif)

A basic FED set up comprises of two parallel plates namely cathode and anode having a narrow gap (ten to hundred micrometer) between these two. The cathode is basically a specially synthesized nanoscale material for electron emission and the anode is a phosphor coated conducting plate, for generation of FE images and basic current voltage characteristics. The level of current, energy of the electrons and the nature of the phosphor determine the colour and brightness of the image. The issues related to the best possible design of a FE set up are: (i) proper design of field emission materials or field emitters capable of emitting electrons at low macroscopic electric fields (typically in the range 1-20 V μm^{-1}) with sufficient current density (typically in the range 10-100 mA cm^{-2}) to generate bright fluorescence from the associated phosphor on the anode. Moreover, they should be ultra high vacuum compatible and mechanically and chemically stable enough during the prolonged process of vacuum conditioning. A high vacuum compatible FED unit consisting of a highly polished stainless steel chamber in diode geometry with complete computer interfacing has been designed and fabricated indigenously (Figure 2).[1]

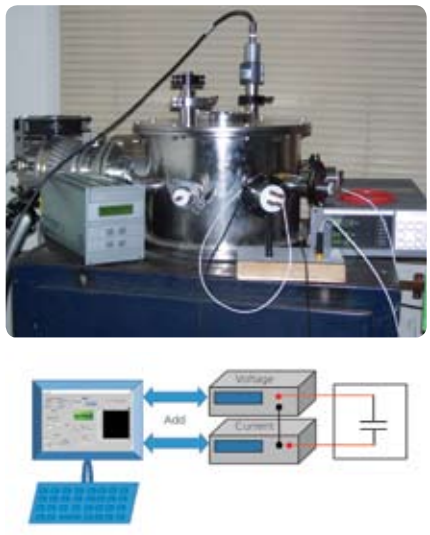


Figure 2: Indigenously developed FED set up and computer controlled interfacing system

The cathode plate is basically a field emitter. It is a carbon nanotube film grown on photlithographically patterned substrate (Figure 3). The anode plate (a phosphor coated ITO plate) is connected to the positive terminal of the high voltage DC power supply unit (Stanford PS 350) through a Keithley Digital Multimeter (DMM 196). A high resistance of 7.7 MΩ is connected in series with the power supply for limiting the current and to avoid accidental damage of power supply and current meter. The cathode electrode is grounded to the power supply and also grounded to earth through the chamber body and mount.

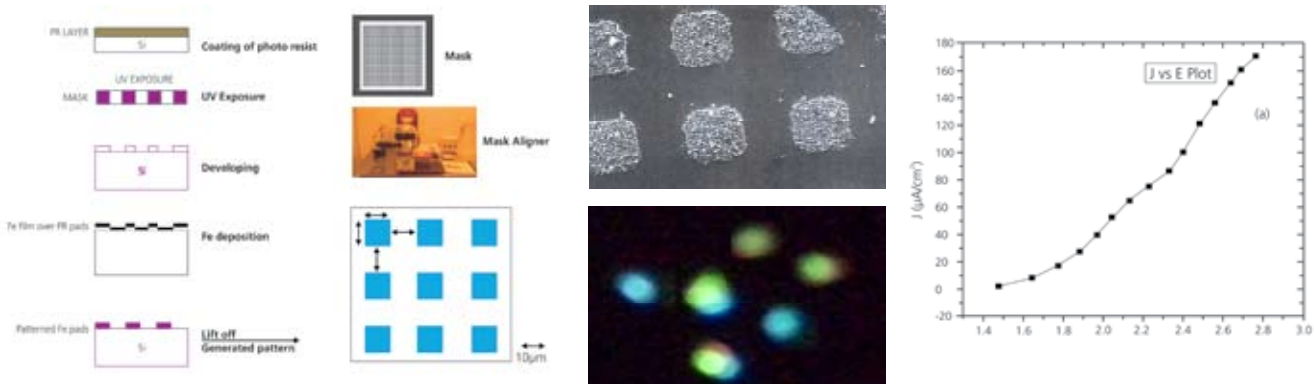


Figure 3: A patterned CNT based field emitter, typical I-V characteristics and a typical image captured in anode plate using a CMOS camera

The threshold field and the field enhancement factor (ratio between localized electric field near emitter tip and the electric field between cathode and anode) are ~ 2.40 V/μm and 6928 respectively, which are very close to present day technology demand.

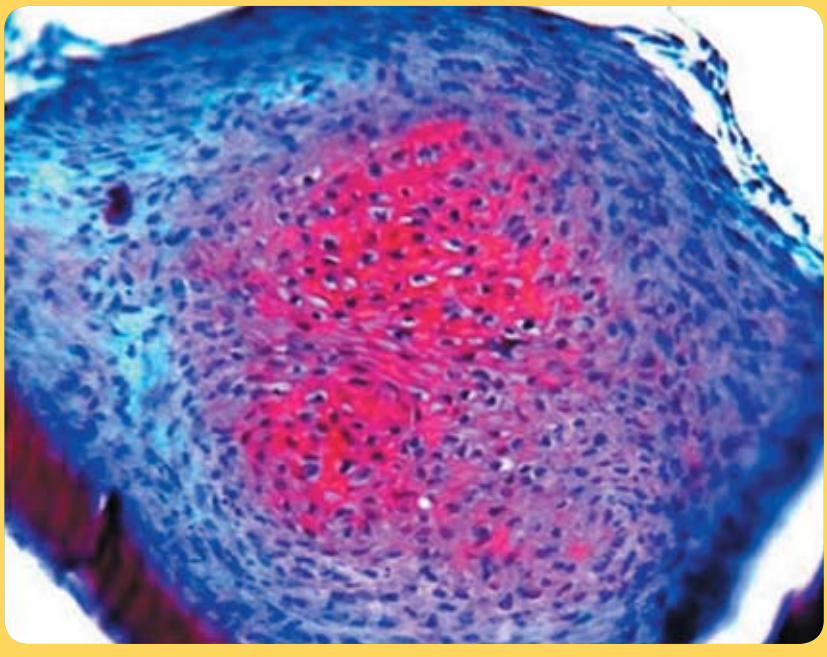
The present state of the art in the technology is that a prototype FED display of dimension 15.3" has been demonstrated by Motorola (Figure 4). However, due to degradation problem of cathode the technology was almost at a standstill stage for few years in the last decade. Recently, with the advancement of the various nanomaterials the technology has shown a significantly enhanced promise. It has been demonstrated that emitters like, nanoparticles embedded in dielectric media or oxide coated carbon nanotubes shows extremely good stability[2,3] and hence can overcome the previous problems.

Figure 4: Demonstration of a prototype FED

(source: www.nanotxstate.org/resources/texassidxie.pdf)

References:

1. S. Ghosh, R. Kumar et al. Rev. Sci. Instrum., under review, 2011.
2. H. Kumar, S. Ghosh et a. Vacuum, 85 (2010) 139.
3. R. Kumar, S. Ghosh et. al. J. App. Phys. under review, 2011.



Tissue engineering research at IIT Delhi ..... (Dr. Sourabh Ghosh)

ACCEPTED ARTICLE

Occupancy (IN/OUT) Sensor Developed in the Mechatronics Laboratory of IIT Delhi

Mr. Dharmender Jaitly[1]

Occupancy (IN/OUT) sensors are installed in many homes, offices and commercial systems. The sensor is able to identify a particular area within a building when it is occupied, and gives the audio/visual message as well as controls the electrical appliances accordingly. There are several end applications associated with an occupancy sensor, for example, counting the number of users in a particular area and reducing utility bill. Occupancy (IN/OUT) sensor can also be used as a security device, occupancy sensor's output can trigger an alarm to the security control room.

Here, I would like to introduce Occupancy (IN/OUT) sensor installed in the Mechatronics Laboratory of Mechanical Engg. Dept. at IIT Delhi. As soon as someone passes through the main door of the Laboratory, it senses the signal, giving a customized audio message "Welcome to Mechatronics Laboratory" while incrementing the counter by one. When somebody leaves the Laboratory the counter is decremented by one with an audio message "Thank you for visiting." When the counter value becomes zero, all electrical points connected to the system can be switched off.

As shown in Fig. 1, the developed occupancy sensor has seven modules. They are explained below:

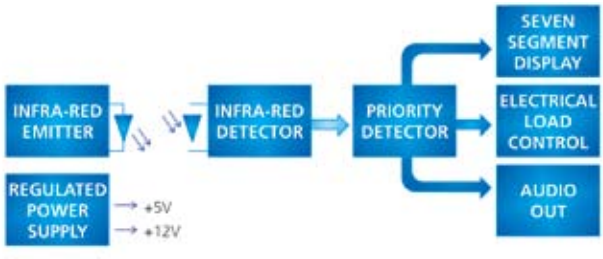


Figure 1: Layout of the occupancy (IN/OUT) sensor

1. **Infrared Emitter Module:** A 38 KHz Oscillator wired around the timer IC generating square wave pulses. These pulses are fed to two channels of Infrared Emitter LEDs. This is shown in Fig.2 (a). The IR LEDs emit 32 KHz light pulses towards the Detector pair.
2. **Infrared Detector Module:** This module senses the corresponding infrared signal emitted by both the infrared LED's. This is shown in Fig. 2(b). When the first and the second Infrared beams interrupted one after another, two high pulses are generated by two timer ICs. Same way two high pulses are generated when someone leaves the Laboratory.
3. **Priority Detector Module:** Two high pulses generated by Detector modules are fed to this module. This circuit takes only first high pulse and discards the second high pulse either of direction and increment or decrement the counter respectively.
4. **Four-Digit Seven-Segment Counter:** Pulses generated by the priority detector Module are fed to up/down pin of Four-Digit Seven-Segment Counter to show the number of persons currently inside the Laboratory. This counter can count up to 9999 persons.
5. **Switching Electrical Load:** When counter value comes to "0000" a low pulse is generated, which breaks the relay contacts to electrical load. As soon as somebody enters the Laboratory and the counter value becomes "0001" a high pulse makes the relay to contact. Correspondingly, the load connected through the relay is switched on.
6. **Customize Voice Message Output:** This module records/plays two 30 seconds of voice messages. High pulse extracted from channels 1 and 2 are also fed to two inputs of the voice input module for generation of customized messages.
7. **Regulated Power Supply:** This module provides the DC regulated power requirement to all module circuits. One +12V DC regulated output provides the current requirement to the relay circuit, and another +5V DC regulated output provides input to other modules of the circuit.

Figure 2(a): Emitter section

Figure 2(b): Detector section

The above sensor is a popular device to anybody visiting the laboratory. This is one of the proud developments in the laboratory amongst many others. It is hoped that the sensor will be liked by others at IIT Delhi and outside of it in order to be adopted by them in their laboratory or organization.

Anybody interested to experience the occupancy (IN/OUT) sensor is welcome to our Mechatronics Laboratory (Block II, Room 420; EPBAX 26596320)!

[1]*The author is the Technical Assistant in the Mechatronics Laboratory, Dept. of Mech. Engg., IIT Delhi. He sincerely acknowledges the inspiration of the Lab.-in-Charge, Prof. S. K. Saha, to write this article and giving his valuable comments/suggestions.*

FACULTY PROFILES

Prof. Surendra Prasad

Dr. Surendra Prasad received his B. Tech (Hons) in Electronics and Electrical Communication Engineering from IIT Kharagpur in 1969, and the M. Tech (1971) and Ph. D (1974) degrees in Communication Engineering from IIT Delhi. He joined the Institute as a faculty member in 1971, and has since served in many capacities. Although he has held several administrative positions like the Dean, Undergraduate Studies (1999-2002), Deputy Director (Faculty) (2002-2005), and eventually serving as the Director (2005-2011), at heart he is a committed teacher and researcher.

Dr. Prasad has been working in the broad area of Signal Processing, with applications to many fields including Radar, Sonar, and Communications. In his formative years as a Researcher, he was influenced greatly by the theoretical prowess of his mentor and advisor, Prof. A. K. Mahalanabis, the practical insight of his other mentor, Prof. P. V. Indiresan and scholarly co-workers like Dr. Vijay Bhatkar and others. As a post-doc at Loughborough University of Technology, UK, he was fortunate to have rubbed shoulders with some outstanding academicians like Prof. J. W. R. Griffiths, Prof. John Hudson and others, where he also got initiated into the area of Array Signal Processing for Sonar and Communication applications - an area, in which he later made several important contributions.

Prof. Prasad's research spanning a period of more than 40 years is concerned with the development of new techniques and algorithms for signal processing; several of these are of fundamental importance and have been extensively cited in literature including text books and reference works. He has also attempted to make some contributions to indigenous R&D efforts, in the form of undertaking technologically advanced projects in sonar and seismic signal processing, array processing, speech processing and digital communications. In the nineties, Dr. Prasad led a team in developing a high speed, state-of-the-art modem for digital communications over the HF Channel, which is of great strategic and commercial importance. The Technology for this and several other products developed by him and his students/ associates have been transferred to Indian Industry.

Dr. Prasad has served as a consultant to a number of organizations, both in the public and private sectors and several of such consultancy assignments have led to major products for defence and industry. Examples: In the first category is the indigenous development of two versions of an HF radio data modem for strategic long-distance communications. The state-of-the-art modems are being manufactured and deployed by the Indian Navy. In the second category, a speech compression algorithm was developed for Analog Devices, Inc., for use in the digital answering machine products. The technical inputs provided by Dr. Prasad to M/s. DCM Data Producers have led to the development of VLSI devices, which provide an efficient realization of the PHY and MAC layers of the famous 802.11a standard for wireless LAN applications. In the last few years and currently, Dr. Prasad and his team are involved in developing algorithms for the next generation VDSL2 standard to deliver broadband access technologies with rates of the order of 200 Mbps over Copper wires, in collaboration with US-based companies Conexant and Ikanos. This work has already led to several international patents for algorithms developed by his team. Dr. Prasad is also active in the areas of Broadband Wireless Communications, Multi-User Communications, MIMO technologies and Cognitive Radios.

Some recent significant results from Prof. Prasad's team include several novel space-time processing techniques for efficient detection of multi-user DS-CDMA signals in a dense

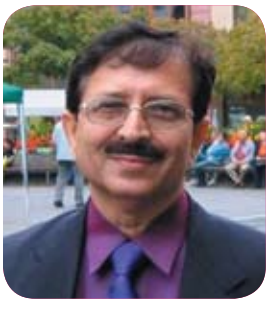
multi-path scenario, and new pre-coding techniques for convenient, blind multi-user detection in heavily loaded systems. These results help to bring the multi-user receivers to practical realization with a view to increase the capacity of 3G and 4G cellular radios by a factor of 2 to 3. Some of these techniques have been patented, while the others have been published in international journals of repute.

As a leader and member of the Joint Telematics Group of the IIT's and IISc Bangalore, Dr. Prasad has been involved with the up-gradation of technical and teacher-manpower in the area of telecommunications in the country through a range of capacity building activities. Dr. Prasad was lately involved in the process of establishment of the Bharti School of Telecom Technology and Management, through co-operation with Bharti enterprises, and the Bharti Foundation, and has served as a Co-ordinator of this School. As Director of the Institute, he took several major academic initiatives.

Dr. Prasad has also helped his students set up their own businesses/companies with a view to encourage entrepreneurship. Two companies, which have evolved out of the laboratory under his guidance and are doing extremely well are SANDS (in Chennai) and Virtual Wire, a recent start-up at Delhi.

Dr. Prasad is the recipient of the Vikram Sarabhai Research Award in Electronics and Telecommunications for the year 1987, the Shanti Swarup Bhatnagar Prize for Engineering Sciences for 1988, and the Om Prakash Bhasin Prize for research in Electronics and Communications for 1994. He is a Fellow of the Indian National Academy of Engineering, the Indian National Science Academy, the Indian Academy of Sciences and the National Academy of Science. He has been conferred the Honorary Degree of Doctor of Technology by Loughborough University, UK, in recognition of his outstanding contributions in communications research. He has also been awarded the prestigious J. C. Bose Fellowship of DST and the meritorious Rajkumar Varshney Award in "Systems Theory" of Systems Society of India for the year 2007. He was honoured as a Distinguished Alumnus of IIT Kharagpur in 2007. He received the Vasvik Award for 2006, and the Life Time Achievement Award of the System Society of India, this year. He has served on many Committees of MHRD, the Planning Commission, AICTE, DRDO, CSIR, among others, and has been a member of the Board of Governors of several NIT's and other educational institutions and a member of the Governing Body of CSIR and CSIR Society, Govt. of India, and on the Board of Directors of EdCIL among others.

Dr. Prasad is proud of having worked with a number of outstanding students and colleagues at all levels over his long career at IIT Delhi. He feels that they have contributed immensely to his learning, and enriched his thinking. Most of his students have risen to top positions in academia, industry and Government and have distinguished themselves in their spheres of activity.



Prof. S. E. Hasnain

'Bacteria don't stop at frontiers and neither should scientists'

Prof. Seyed E. Hasnain (PhD, DSc (h.c.), DMedSc (h.c.), FNA, FTWAS, ML), is currently Professor of Biological Sciences at the Indian Institute of Technology, Delhi. He did his primary and secondary schooling from Gaya High School. He later obtained his MSc (1977) and PhD from Jawaharlal Nehru University, Delhi (1980). He worked at the University of Delhi before leaving for a National Cancer Institute postdoctoral fellowship at the University of Alberta, Canada, where he was subsequently selected for the 'Alberta Heritage Foundation for Medical Research Fellow Award to work in the Department of Medicine.

Prof. Hasnain spent few years at Texas A&M University, USA and in 1987 joined as a Staff Scientist at the National Institute of Immunology, New Delhi. In 1999, he was appointed as the first Director of the Centre for DNA Fingerprinting and Diagnostics, (CDFD), Hyderabad, and in less than 7 years he made CDFD a gold standard for DNA analyses services and research in basic biology. In December 2005, he was appointed by His Excellency the President of India as the Vice-Chancellor of University of Hyderabad, a position he served until March 31, 2011. Professor Hasnain is a Visiting Professor at the King Saud University, Riyadh, Saudi Arabia.

He has contributed extensively to Molecular Infection Biology and Functional Epidemiology of Mycobacterium tuberculosis, the TB causing bacterium, and has >200 publications in peer-reviewed journals of high impact, and >dozen patents. He has mentored >hundred PhD, MD and Post Doctoral students, four of whom received the INSA Young Scientist Medal.

Hasnain's lab earlier contributed to our understanding of high expression of foreign genes in insect cells. For the last over a decade his work on the bacterium causing tuberculosis has addressed issues of dissemination and virulence in the population of this pathogen and also promises new interventions and diagnostics against this disease.

He is a very well recognized scientist and a Fellow of all major Science Academies of India (FNA, FASc, FNASc). He has almost all major Indian Science Awards to his credit: G.D. Birla Award, Shanti Swarup Bhatnagar Prize, FICCI Award, J.C. Bose National Fellow Award, Ranbaxy Research Award, Goyal Award, Bhasin Award and several others. He is the first Indian elected as a Member of the prestigious German National Academy of Sciences Leopoldina and one of the youngest to be elected as a Fellow of TWAS, Trieste, Italy. Internationally, Prof. Hasnain is a recipient of the prestigious Humboldt Research Prize, awarded by the Alexander-von-Humboldt Foundation, Germany; as well as the very exclusive Robert Koch Fellowship, of the Robert Koch Institute, Berlin. Prof. Hasnain received the Padma Shri (Civilian Award) from His Excellency, the President of India in 2006.

The Ministry of Human Resource Development, Govt. of India, appointed him as a Member (2011) of the University Grants Commission. Prof. Hasnain was awarded the Doctorate of Medical Sciences Degree (honoris causa) by Queen's University, Belfast, Northern Ireland, at a ceremonial Convocation function held on July 4, 2011, for his outstanding and acclaimed research work on Tuberculosis. He is the third Indian to receive this honor after Dr. A. P. J. Abdul Kalam (2009) and Professor Amartya Sen (2010).

Prof. Sayed E. Hasnain receiving Robert Koch Fellowship Award from the Robert Koch Institute, Berlin, Germany

Chairman of the Biotechnology Advisory Committee (Govt. of Andhra Pradesh) to the Chief Minister of Andhra Pradesh on Bio-tech related issues for several years, he is a Member of Bio-technology Advisory Committees of Govt. of Jharkhand, Govt. of Gujarat and Govt. of Kerala. He was an Honorary Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore and he has been re-nominated to the Scientific Advisory Council to the Prime Minister (SAC – PM), the highest decision and policy making body for Science & Technology for the country, and is also a Member of the Scientific Advisory Committee to the Union Cabinet (SAC-C). He is/has been associated with the Editorial Board of several peer reviewed journals in India and abroad. He has also been associated with the Boards of Governors/ Scientific Advisory Committees/ Academic Councils of several National Institutes such as National Institute of Advanced Studies, Shimla, IISc, IIM, IISER, etc.

IIT Delhi underwater acoustics research .....(Dr. Rajendar Bahl et. al.)

FITT/IITD HAPPENINGS

A workshop on **Innovation and Health care** was jointly organised by FITT and ARA Research Foundation on Oct 4, 2011 at IIT Delhi. The event was inaugurated by Prof. Shevgaonkar, Director IIT Delhi and the inaugural address was delivered by Dr. N. K. Ganguly, former DG, ICMR. The event was part of an innovation Forum envisaged to bring together renowned scientists, life sciences' innovators and entrepreneurs in the country to focus on education, training and capacity building in innovation and IPR generation that will build the competitive advantage for the country. It was a well attended meet with several top notch medical professionals and faculty scientists of the institute in useful dialogue that emphasised partnership and creation of an enabling environment for innovations in life sciences to address India's health challenges including new drug discovery for neglected diseases.

Workshop: Innovation and Healthcare, Oct 4'11

In partnership with Samsung, FITT organised the **Samsung Innovation Awards 2011** at IIT Delhi. The criteria of the winning projects were based on degree of innovation, feasibility, usability, relevance, time to market and overall impact. The winning student-faculty teams were felicitated on Nov 16, 2011 with cash prizes by Mr. Jung Soo Shin, President and CEO of Samsung South West Asia.

Samsung Innovation Award Ceremony, Nov 16'11

The 37th meeting of the Governing Council of FITT was held on Oct 10, 2011 and it was chaired for the first time by the new Institute Director Prof. R. K. Shevgaonkar.

The 17th AGM of FITT was held on Nov 17, 2011 at IIT Delhi. The discussions that followed the formal business generated keen interest amongst the participants.

At the AGM of FITT

INNOVATIONS

Opportunities for IP Licensing

Title	PI
A process and composition for obtaining a versatile mechanism for efficient down-streaming of proteins	Prof. M. N. Gupta
Synthesis of Gold and Silver nanoparticles and films using spray pyrolysis technique	Prof. V. Dutta
An improved micro-heater in silicon substrate for sensors using trench formation, backfill and CMP	Prof. S. Chandra
Walking stabilizer	Prof. S. N. Singh
Compositionally dispersed size-selected metal nanoparticles for enhancement of solar cell efficiency	Prof. B. R. Mehta
In-Plane wicking measurement system	Dr. A. Das
Efficient refolding method for large multi-domain recombinant protein Malate Synthase G (MSG)	Dr. T. K. Chaudhuri
A novel variant of L-Asparaginase and use thereof	Dr. B. Kundu
Method for preparation of dispersible myco-tablets for bioremediation	Dr. A. Malik
Air entrainment in cement and cement mortars by Colloidal Gas Aphrons (CGA) for manufacture of aerated concrete	Prof. A. N. Bhaskarwar
New orthosis for simultaneous 3D correction of club-foot	Dr. P. M. Pandey
Bipolar charge plasma transistor: A novel three terminal device	Dr. M. J. Kumar
PVA supported resins for arsenic separation and the products thereof	Prof. B. Gupta

Technology Profiles

Forced folding of peptide chain: A multi-purpose chemical model

Prof. V. Haridas,
Department of Chemistry, IIT Delhi

During the past decade, scientists have produced several unnatural proteins *in vitro* using recombinant DNA technology. This approach has high commercial importance and also is a valuable tool for understanding the mechanism of protein folding and function. Although our understanding of protein folding and the function is incomplete, scientists have been able to successfully design and synthesize artificial peptides that show some of the properties of natural proteins.

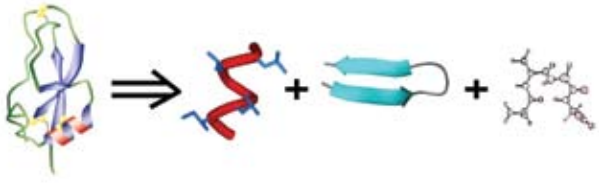


Figure 1: A retrosynthetic analysis of protein structure

Secondary structure is one of the deciding factors determining the function of protein. Controlling the secondary structure of peptide is an enduring objective in chemical biology. Ever since the Anfinsen's experimental demonstration of the role of defined amino acid sequence in determining the secondary structure of protein, there started an era to understand and control the secondary structure of proteins (Figure 1). The long collaboration between chemists and biologists in a view to understand the protein structure-function relationship unearthed plethora of uncharted avenues to explore. An accurate prediction and synthesis of peptide or protein with desired secondary structure is still far from reality. This long-standing problem of conformational control continues to be a challenging problem to scientists. The studies to control peptide conformation gave us not only a deeper insight into the folding of biomolecules but also avenues for the design of minimalistic models. Such designed secondary structure mimetics gave a strong impetus to medicinal chemistry because of their desirable properties like protease resistance and blood brain barrier crossing ability.

We were able to demonstrate that any primary sequences can be engineered to any desired secondary structure by using a universal secondary structure inducer. These novel compounds will be of immense significance in understanding the fundamental principles of protein folding and function. These peptide mimetics allow us to understand the transient bioactive conformations. Moreover, our designed compounds are expected to have high therapeutic utility as evident from their good viral inhibitory properties.

An Optical Interconnection Bi-directional Data Vortex Network

Prof. Vinod Chandra,
Department of Electrical Engineering IIT Delhi

Data Vortex architecture (DV) is a unidirectional, highly scalable, all optical multistage interconnection packet switching network. In the present work, we propose Data Vortex architecture with bidirectional links in which the packets are routed both in the forward as well as in the reverse directions with enhanced fault tolerance. The feasibility of data flow through a single node in both the directions with hardware model and routing is simulated. A DV is essentially a synchronous unidirectional switch with packets moving in the forward direction. In order to have a bidirectional operation, reverse paths along with the forward paths as in DV are also provided. The connection or the routing pattern of Bidirectional Data Vortex switch (BDV) is same as in DV, except that the packets in DV move from the outermost cylinder level to the innermost cylinder level, while in BDV, the packets are also allowed to move in the reverse direction from the innermost to the outermost cylinder level.

Advantages:

- Two DV setups are required to perform bi-directional operation
- BDV uses same DV setup with additional passive switches handles bi-directional data flow
- Feasibility of data flow in both forward and reverse direction is checked using Rsoft opt.sim simulator and BER characteristics has been verified with the hardware BER results of DV
- Same SOAs and Electrical module for switching is used for bi-directional data flow
- Alternate priority is given for bi-directional data flow

Keywords: BDV, unidirectional, bi-directional

An Optical qxq Switch for Fault Tolerant Routing of Data Communication

Prof. Vinod Chandra,
Department of Electrical Engineering IIT Delhi

The invention relates to interconnection network for distributing data across the network computers. More specifically, the present invention relates to optical qxq switch for fault tolerant routing of data communication and associated hardware implementation thereby minimizing the control and logic circuits.

High performance computing requires parallel processing of data by large number of computers. These computers are required to be interconnected so that they can share data and computed results. This requires an interconnection network for connecting a large number of computers (which can go up to several thousand processors). If number of links that is available between various computers is less, then the bandwidth available for the interconnection will be less. This will lead to slowing down of the computational speed of the computers, as sharing of data and results will be at slow speed. Thus, any method that will increase the bandwidth of the interconnection network will lead to improved latency (viz. mean number of hops propagated by the packets) of the network. In addition to that, the increase in number of redundant links leads to higher fault tolerance as failure of few links can be tolerated due to the fact that alternate links are available to the failed links.

Advantages:

- Achieves an increased bandwidth by using nodes in the interconnection network which has (qxq) input/output links
- The congestion of the interconnection network is minimized by the proposed priority scheme
- The number of links are increased in each of the nodes of the interconnection network from minimum requirement (2x2) to (qxq)
- Achieves greater fault tolerance and lower latency by increasing the number of links at each node in the interconnection network
- Achieves high throughput and low latency

R&D/INVESTIGATIVE PROJECTS

S. No.	Title	PI/Dept.
1	Automated fault detection and Diagnostics Rules for HVAC Systems (Ph.-II)	Dr. S. Jain, DME
2	Operational Control Centre Design & Ergonomic Study for BMRC Ltd (Phase-III)	Dr. L. K. Das, IDDC
3	Implementation of Quality by Design (QbD) for production of biosimilar products	Dr. A. S. Rathore, Chem. Engg.
4	Flow Sheet Simulation and Optimization of CO_2 Production Process	Dr. M. A. Shaik, Chem. Engg.
5	WATer and global CHange (WATCH)	Prof. A. K. Gosain, CE
6	Quality by Design (QbD) based regulatory filling for biotech products	Dr. A. S. Rathore, Chem Engg.
7	Development of compliant surfaces for reduced lube oil consumption	Prof. J. Bijwe, ITMMEC
8	Design of long distance pipeline for pneumatic conveying of fly ash	Prof. V. K. Agarwal, ITMMEC
9	Design inputs for pneumatic conveying of fly ash	Prof. V. K. Agarwal, ITMMEC
10	Technological Trajectories for Climate Change Mitigation in China, Europe and India	Prof. A. Sagar, HuSS
11	Indigenous development of MR Fluid and demonstration of proto MR Device	Dr. S. Jha, DME
12	Development of software for underwater domain awareness (UDA) for CICS	Prof. R. Bahl, CARE
13	Characterisation of polymeric isolators for dynamic properties and ……properties	Prof. A. K. Darpe, DME
14	Analysis and Design Simulation of Hanger and Cabin Bracket	Dr. S. V. Modak, DME
15	Groundwater Resources Assessment and Development Potential of Yamuna Flood Plain in NCT of Delhi – Phase-I: Preliminary Assessment	Prof. S. N. Naik, CRDT
16	Groundwater Resources ……NCT of Delhi – Phase-II: Groundwater Development Potential Assessment incorporating Quality Aspects	Prof. S. N. Naik, CRDT
17	Validation of Selection and location of Surge Protection devices in Electrical Circuit at BTS Sites	Dr. S. Mishra, DEE
18	Formability Studies on IS 513 Steel Sheets	Dr. D. Ravi Kumar, DME
19	Development of Practical Oriented Laboratory Manual for Agilent, Model N9923: A handheld Network Analyzer (6 GHZ), along with a set of 10 devices	Prof. S. K. Koul, CARE
20	Development of small molecules targeting cancer protein	Dr. N. G. Ramesh, Cy
21	Design of test apparatus and testing of EPS panels as per ASTM standards	Dr. S. Bishnoi, CE
22	Viscosity of m-aramid dope solution	Prof. V. Choudhary, CPSE
23	Analysis of VMCH sample	Prof. V. Choudhary, CPSE

24	Detailed Project Report (DPR) on FRP boxes for currency transfer – Phase-II	Prof. N. Bhatnagar, DME
25	Solar panel design and optimization for running tubewell	Dr. S. Jha, DME
26	Solar power operated water pump	Dr. S. Jha, DME
27	Development of composites for tribological applications	Prof. J. Bijwe, ITMMEC
28	Design and development of 5-bit RF MEMS switched line phase shifter and LTCC package for DMTL phase shifter	Prof. S. K. Koul, CARE
29	Process development and optimization studies for therapeutic biotech products	Dr. A. S. Rathore, Chem. Engg.
30	Study on Impact of HVDS/FRP Schemes	Dr. B. K. Panigrahi, DEE
31	Treatment of Producer Gas Plant Effluent	Prof. T. R. Sreekrishnan, DBEB
32	CFD simulations for analyzing effects of stent designs treatment of cerebral aneurysm	Dr. A. S. Rathore, Chem. Engg.
33	3-D CFD model for the avalanche like flows (snow chute) interaction with avalanche control structures	Prof. M. R. Ravi, DME
34	Driver behavior study in India	Prof. D. Mohan, CBME
35	Development and commercialization of biotech therapeutic products	Dr. A. S. Rathore, Chem. Engg.
36	Experimental and Numerical Investigations of Dispersed Gas-Liquid Flow & Mixing in a Basic Oxygen Furnace	Dr. V. V. Buwa, Chem. Engg.
37	Modeling and optimal design of electrodialysis (ED) powered by renewable energy (i.e. PV power)	Dr. A. Shukla, Chem. Engg.
38	Monitoring and optimization of Ultra-filtration (UF), Microfiltration (MF) and Membrane Bioreactor (MBR) unit operations	Dr. A. S. Rathore, Chem. Engg.
39	To develop high dielectric constant thin film materials	Prof. B. R. Mehta, Phy
40	Design and development of high capacity biogas enrichment system using water scrubbing method	Prof. P. M. V. Subbarao, DME
41	Development of toolkit on public transport and accessibility	Dr. G. Tiwari, TRIPP
42	Development of toolkit on road safety & safety audits	Dr. G. Tiwari, TRIPP

CRYSTALLIZING THE FUTURE

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INDIAN INSTITUTE OF TECHNOLOGY DELHI

GOLDEN JUBILEE

The Golden Jubilee Logo consists of four parts, namely a timeline foundation, the iconic of the Dogra Hall, a pair of crystal wings and the rising arc of organic knowledge

Norner team at FITT

PROFESSIONAL DEVELOPMENT PROGRAMMES

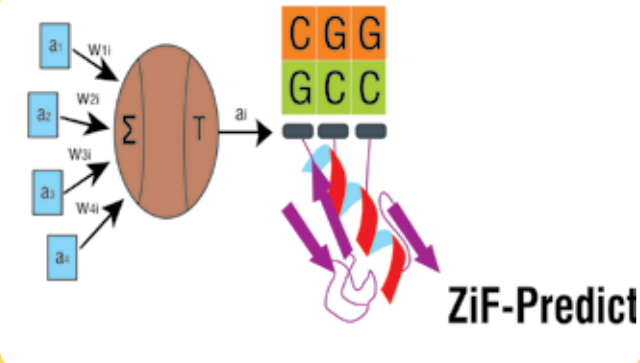
Forthcoming HRD Programmes (early 2012)#

Title	Date	Faculty/Dept.
Training on Thermo Hydraulic Design of Shell and Tube Heat Exchange with Specialization in Feed Water Heater Design^	Jan.21 '12 onwards (25 lectures)	Prof. P. M .V. Subbarao, ME
Training Programme on Tribology for ONGC Maintenance Engineers$	Feb. 14-16 '12	Dr. H. Hirani, ME
Short course on "Artificial Neural Networks in Seismic Control of Structures" http://www.iitd.ac.in/courses/stc_details	Feb. 8-17 '12	Dr. M. M. Rao, CE
Workshop on "Advance in Multimedia Processing"	Feb. 2012 (under finalization)	Dr. S. D. Roy
Certificate course on "Embedded Systems and Applications"	Feb. 20-March 2 '12	Prof. S. Kar, EE and Dr. B. Lal, EE
Executive Development Program on Marketing Strategy	March 17-18 '12	Dr. M. Sagar, DMS
Executive Development Program on "Finance for Non-Finance"	May 16-18 '12	Prof. P. K. Jain, DMS
Short course on "Economics of Renewable Energy Based Power Generation"http://www.iitd.ac.in/courses/stc_details	May 29-June 1 '12	Prof. T. C. Kandpal, CES
International Workshop on SWAT http://swatmodel.tamu.edu/media/43325/2012-swat-conf-flyer.pdf	July 16-17 '12	Prof. A. K. Gosain, CE
2012 International SWAT Conference http://swatmodel.tamu.edu/media/43325/2012-swat-conf-flyer.pdf	July 18-20 '12	Prof. A. K. Gosain, CE

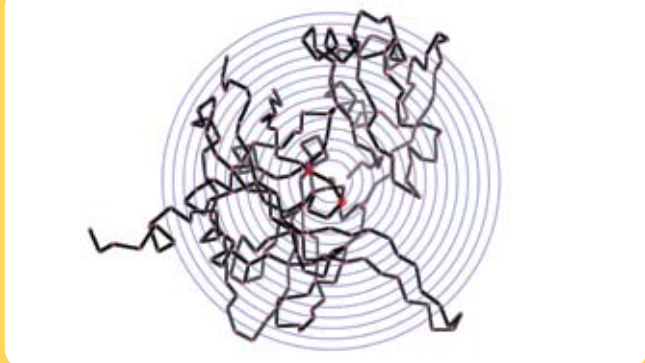
#Participation Fee Based; $ Sponsored by ONGC Vadodara, ^ Sponsored by ISGEC

Professional Candidates' Registration Programme

A semester-long unique knowledge augmentation and skill enhancement programme at IIT Delhi for qualified professionals working in industry and Research Organizations. All major disciplines of Science and Engineering, and also relevant courses from the Humanities, Social Science and Management streams which are being conducted at IIT Delhi are covered. The two semester sessions in the academic year start in the months of July and January, the exact dates being notified in advance. Contact: kirityroy@yahoo.com, uaswal@gmail.com



Molparia, B., Goyal, K., Sarkar, A., Kumar, S. and Sundar, D. (2010). Zif-Predict: a web tool for predicting DNA-binding specificity in C2H2 zinc finger proteins. Genomics, Proteomics & Bioinformatics 8(2):122-126.



Revisiting protein folding.... (Dr. Aditya Mittal)

MISCELLANEOUS

Corporate Membership of FITT

FITT invites the industry/industry associations/R&D organisations and financial institutions to become corporate members of FITT at a nominal annual subscription. Membership Form can be mailed on request or can be downloaded from www.fitt-iitd.org. Contact: jasleen.bhatti@fitt.iitd.ac.in

New Corporate Members (July-Dec' 2011):

- ACME Tele Power Limited
- Escorts Construction Equipment Limited
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- Ecosense Sustainable Solutions Pvt. Ltd.
- Usha Breco Limited
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- Anuvi Chemicals Ltd.
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- Skyquest Technology Pvt. Ltd.
- Escorts Construction Equipment Limited

Techno-entrepreneurship Supports

In Helping Power the Ideas – FITT extends following supports under approved Government Schemes:
Technological Incubation and Development of Entrepreneurs (TIDE), DIT: to financially support technology ventures (IT and IT& ES) at incubators during early stages of their development, (www.mit.gov.in)

Seed-Support to Incubatees, TDB: for addressing the varied development needs of the start-ups at incubators. (www.tdb.gov.in)

Technopreneur Promotion Programme (TePP), DSIR: to enable innovators to become technology entrepreneurs through financial support/mentoring – up to Rs. 15/45 lakh (www.dsir.org)

Entrepreneurial and Managerial Development of SMEs through Incubators, MSME: to nurture/promote technology/knowledge-based innovative ventures through financial/incubation support (www.msme.gov.in)

News and Views

Amrita varsity develops indigenous insulin pump
Source: The Hindu 14.11.2011

The fight for and against antibiotics
Source: The Hindu, 08.11.2011

IIT-Delhi alumnus Soumitra Dutta to be new Dean of the Ivy league Cornell University's business school
Source: Times of India 10.01.2012

Breath test by Indian Scientists Promises faster diagnosis of TB
Source: Mint, 08.11.2011

Industry academia tie–up looks to aid education in smaller cities
Source: Mint, 22.11.2011

Rohit Pande, a graduate of IIT - Delhi and IIM - Calcutta has launched his innovation Classpad – a rival to Akash Tab
Source: Times of India 02. 01.2012

Creating an ecosystem of innovation
The magic mantra for most successful corporate houses seems to be "cheaper, quicker, better". But is there any scope to integrate technology with innovation to fuel inclusive growth? India is considered to be one of the emerging superpowers of the future but needs to put in place that culture of innovation – an ecosystem will help promote innovation.....
Source: The Hindu 02.01.2012

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