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Bringing industry and academia together...

The Safe Food....

The ***Maggi*** controversy is yet another wake up call for each one of us to be vigilant towards food safety. In particular, the authorities need to put in place reliable and robust systems to ensure that only safe food reaches the people. And that includes having requisite standards (Codex) in place for implementation not only for the well organized formal sector dominated by MNCs and large Indian companies but also the unorganized and tiny sectors dominated by mom and pop stores. The current overdrive should not fizzle out and should not stop at just noodles and such other quick-to-make eatables. All kinds of food, be they from the neighbourhood *'Halwai'* or bakery or a fast-food joint or from large organized trade – all need to be scientifically tested – in accredited labs having rigorous test/ standard norms. The same applies to the ubiquitous spices, flavourings and colourings. The test reports should be given wide publicity not only to make people aware but, also to ensure that regulation, manufacture and trade becomes responsible. However, there is no scope for creating any panic or revival of any kind of inspector *raj*. And, why should our standards not be raised. The necessity of processed, packaged and ready-to-eat food etc. cannot be overemphasized but, not at the cost of safety. If big food companies can afford to spend millions on promotions or in scaling up their business operations, they should necessarily ensure that safe materials and processes go into the manufacture and distribution of their food products, and thus assuring the consumers. It may not be imprudent to bracket adulterated drugs and unsafe foods together with similar penalties. The emphasis should be on self certification with regular checks and severe penalty for non-compliance. And, again the buck does not stop here. The manufacture of the permitted food ingredients and additives is another area that needs close attention. Non-food grade ingredients/chemicals that are likely to be misused should be banned altogether, and safe and green alternatives ought to be encouraged. The suggestion in some quarters of labelling the packaged foods on their degree of healthy quotient may make a useful qualitative indicator that can help people make informed choices. The scientific experts can be called upon to proffer needful advice, and suggest interventions where necessary. Also, the scientists (including in academia) need to work on such challenges more often. The clean India mission should also include cleansing the unsafe segments of the food industry and ensure a safe and healthy **'Made in India'** food !

Dr A Wali

1

Tech Tales...

CEST MRI: *In vivo* Molecular Imaging Technique

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Most of diseases are initiated by abnormal change in bimolecular/ biochemical environment at cellular level. *In vivo* mapping of molecular information has a great potential in disease diagnosis, particularly at early stage of a disease. Molecular imaging is the visualization, characterization, and measurement of biological processes *in vivo* at the molecular and cellular levels. A number of imaging techniques like PET, SPECT, optical imaging, MRI and ultrasonic are being used for molecular imaging. Molecular imaging using PET and SPECT is based upon administration of radionuclides labelled molecules. Bioluminescent and fluorescent are optical imaging techniques used for molecular imaging. Optical imaging has low depth coverage. Ultrasonic molecular imaging has shown promise in assessing angiogenesis, inflammation, and thrombus. Contrast agents like microbubbles, echogenic liposomes, gold particles, etc. are used for Ultrasonic molecular imaging. In MRI, molecular imaging can be performed using either endogenous or exogenous contrast agents. Another advantage of MRI is that it can simultaneously provide both high resolution structural and molecular images. Various molecular imaging techniques differ in term of nature of molecular information, spatial and temporal resolution, depth coverage, safety, portability, etc. Compared to other type of imaging techniques, molecular imaging is quite new and there is lot of scope for further developments. In this article, an advanced MRI technique, named as chemical-exchange-saturation-transfer (CEST) MRI, for high resolution mapping of molecular information is reported.

MRI is a non-invasive technique for imaging internal organs of body. It's an interdisciplinary area where science and engineering principles are combined for solving biology problems. Unlike other imaging technique, which can provide only one type of information, MRI can be used to obtain multiple type of information including structural, functional, hemodynamic, physiological and molecular/biochemical level. MRI helps in characterization and understanding of tissue and hence it's being used for diagnosis of diseases as well as monitoring of treatment responses. Conventional MRI scanners mainly provides structural level information. However, advanced MRI techniques like diffusion MRI, functional MRI, perfusion MRI, magnetic resonance spectroscopy (MRS) can be used for imaging diffusion, functional, hemodynamic, physiological and molecular information.

CEST MRI Techniques Basics: CEST-MRI is based upon chemical exchange phenomenon between protons of small molecules and bulk water (1, 2). In CEST-MRI experiment, first of all magnetization of protons of small molecules exhibiting exchange phenomenon is saturated using a radio frequency (RF) pulse for a certain period of time. Due to chemical exchange phenomenon, this saturated magnetization is transferred to bulk water and hence results in reduction of bulk water magnetization signal. Therefore, by subtracting MRI images without and with RF saturation, CEST contrast can be generated.

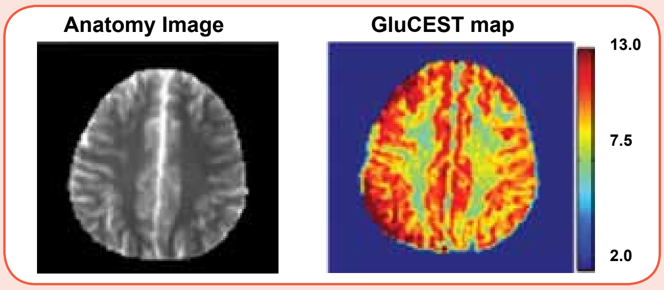

Figure 1: Anatomical MRI image (left) and GluCEST (%) map (right) of human brain at 7T MRI. GluCEST map represents distribution of neurotransmitters (Glutamate and GABA).

This CEST contrast is an indirect measure of molecular information using MRI. Usually, molecules having amide (-NH), amine (-NH2) or hydroxyle (-OH) protons group exhibits chemical exchange phenomenon and can be imaged using CEST MRI. CEST MRI is sensitive to *concentration of molecules, pH of tissue environment, chemical exchange, tissue temperature,* MR field strength and RF saturation parameters and field infomogenity. Due to dependence on multiple factors mentioned and overlap with other saturation effects, quantitation of CEST contrast is challenging.

CEST-MRI Review: The effects of chemical exchange on the NMR spectrum were reported as early as 1951 and investigated intensively during the early days of NMR. In a landmark paper published in 1963, Forsen and Hoffman studied moderately rapid chemical reactions by means of nuclear magnetic double resonance. In the last two 20 years, there has been a surge in NMR exchange applications because of the realization that saturation transfer experiments can be designed that allow a large sensitivity enhancement. The first to demonstrate that exchange between labile protons of low-concentration solute molecules and water protons provides a sensitivity enhancement scheme were Balaban, et al (2000), who named this new MRI contrast mechanism chemical exchange dependent saturation transfer (CEST). After this landmark paper, research efforts were put on designing new molecules exhibiting several exchanging protons, particularly for preclinical applications. Zhou J, et al (2003) reported first preclinical application based upon endogenous CEST contrast agent called as amide proton transfer (APT). Several studies have reported application of APT in different disease conditions for detecting change in molecular concentration and tissue pH (3-5). In addition to APT, several new endogenous molecules exhibiting CEST contrast has been reported in *ex vivo* and *in vivo* studies (6-8).

Specific Applications of CEST MRI: Several applications of CEST MRI has been reported. High resolution distribution of molecules can be obtained *in vivo*. Several clinically significant molecules like Glutamate, GABA, Creatine (Cr), Myo-inositol, Glucose, Glycosaminoglycan, etc. exhibits CEST contrast. In addition to concentration mapping, changes in pH can also be detected using CEST MRI (4, 6). CEST MRI can be used for tracing externally administered CEST contrast agents, which has applications in exploring metabolic pathways and targeted drug delivery. Both paramagnetic and diamagnetic CEST contrast agents are being developed. Another beautiful application of CEST MRI is *in vivo* monitoring in Creatine (Cr) kinase (CK) reaction during exercise. Conversion of phosphocreatine (PCr) to Cr was demonstrated by performing in magnet exercise (Figure 3). During exercise, PCr decrease, which results in increasing Cr concentration. After exercise Cr start decaying to original level.

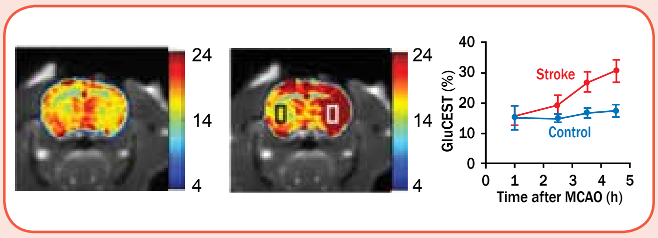

Figure 2: GluCEST map as a marker for change in pH during ischemia in rat brain. (9.4T)

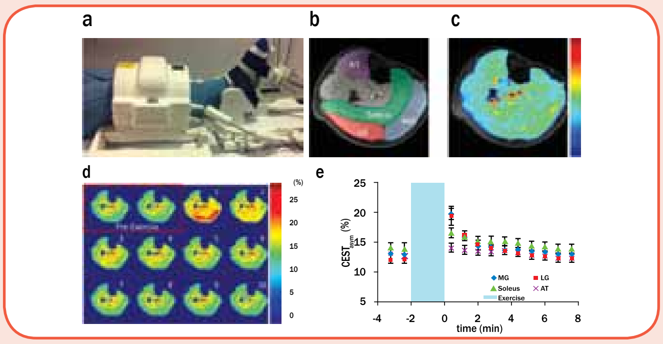

Figure 3: (a): In magnet exercise setup consisting of an MR compatible pneumatically driven pedal and a RF knee coil for imaging of the lower leg. (b): Anatomical image with the major muscles (lateral gas-troc-nemius [LG], medial gastrocnemius [MG], soleus, and anterior tibialis [AT]) of the lower leg manually segmented. (c) CrCEST map at 7T. Bottom row images (CrCEST) show changes in Creatinecontent before and after exercise.

CEST Contrast vs MR Scanner Field Strength: CEST contrast highly depends upon MR field strength. In general higher field strength provide better CEST contrast. Most of the CEST MRI experiments has been performed on high fields (≥3T) MR scanners. Depending upon exchange rate, most of the molecules provide observable CEST contrast only at higher MR field (≥3T). A number of clinical applications of CEST MRI at ultra-high field whole body 7T MRI scanner has been demonstrated (7). Similarly, a number of preclinical applications of CEST MRI has been reported (4,7). At present, 3T MRI scanner is the most popular clinical MR scanner. Recently, a number of clinical applications of CEST MRI has been reported at 3T MRI scanner (5). Potential of CEST MRI at clinical MRI is being further explored.

Research Scope in CEST MRI: In spite of great potential of CEST MRI in mapping high resolution molecular information, at present, clinical application of this technique is limited. This is mainly due to the lack of availability of CEST MRI pulse sequence, lack of standard protocols, complex quantification, etc. There is wide scope in development of CEST MRI pulse sequences for optimum CEST contrast, development of methods for accurate computation of CEST contrast, standardization of protocol, exploring new CEST molecules, and in exploring new application.

Future of CEST MRI in India: In the developed countries, CEST MRI is one of the hot topic of research, particularly in MR field, and still there is a lot of scope and potential in this field. In India, as such the number of MRI scanners is growing quite fast; however, there are very few MRI research centres. Few ultra-high field pre-clinical animal MR scanners are available at places like AIIMS Delhi, INMAS Delhi etc. Since MRI is highly interdisciplinary area, both technical and clinical peoples has to work in strong collaboration for solving clinical problems using MRI. Unfortunately, in India there are no MRI facility in the technical institutes like IITs. Researchers from technical institutions interested in MRI research require a strong collaboration with clinical peoples (like radiologist) of hospital/institute having MR facility. Recently, we have started CEST MRI in collaboration with Fortis memorial research institute Gurgaon. To the best of my knowledge, this is the first research activity on CEST MRI in India. We are in the process of starting CEST MRI research work at AIIMS also.

In conclusion, CEST MRI is a novel non-invasive molecular imaging technique having great potential in molecular characterization of tissues and hence in disease diagnosis. There is a lot of scope for research in CEST MRI field, particularly in developing new MR pulse sequences, new methodology for accurate quantitation of contrast, exploring/designing new CEST molecules and in exploring potential application for disease diagnosis.

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Frugal, Inclusive and Flexible Innovation

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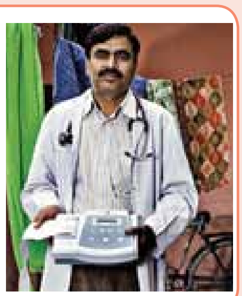
Prahalad (2004) classified the communities and individuals who live in poverty and disenfranchisement, especially in developing nations, as base of the pyramid (BoP). Extant literature has used the concept of 'innovation for inclusive growth' and 'inclusive innovation' interchangeably to research the frugal innovations initiatives that creates opportunities of improved offerings to the BoP in the informal economies. There exists a plethora of research on innovations in informal economies and developing nations and their difference with developed nations. Moreover, scholars have used various terminologies for the phenomenon of inclusive innovations in developing nations. Some of the recent concepts that look at inclusive innovations pertaining to emerging countries include creative improvisation (Prahalad, 2004), Jugaad innovation (Gulati, 2010; Radjou, Prabhu and Ahuja, 2012), reverse innovation (Govindarajan & Ramamurti, 2011) and frugal innovation (Wooldridge, 2010). George et al (2012) define Jugaad innovation as "innovative, low-cost and high-quality products and business models originating in developing countries and exportable to other developing countries or even the developed world". Furthermore, Jugaad requires intelligence of innovators to quickly adapt to the unforeseen situations and circumstances by a frugal way of innovation and above all being flexible. Intelligence in Jugaad innovation "isn't about seeking sophistication or perfection by over-engineering products, but rather about developing a 'good-enough' solution that gets the job done" (Radjou et al, 2012).

Jugaad innovation can be noticed in varied industries – both products and services - such as automobiles, medical devices, housing, telecommunication, banking, energy, training, and education sectors. The classic examples are - Tata Nano car which was launched for a cost less than £2000, affordable electric car in China, mini and handheld ECG machine developed at GE's Bangalore R&D center which is portable and costs less than half of conventional ECG machines, and the home projects which costs $300. In services, Jugaad innovations include Grameen Bank's microfinance, Husk Power's off-grid energy, and Telenor's Easy Paisa. Apart from these there are numerous innovations that isn't even labeled as Jugaad without consciously being aware of in practice, but equally has components of Jugaad innovation.



Jugaad is not a new idea of innovation in informal economies and developing nations. Inventors and entrepreneurs of the developed world in the past such as Benjamin Franklin in 18th century America came up with frugal solutions for everyday problems such as the Franklin stove, lightning rod, bifocals, and carriage odometer, using limited resources (Franklin, 2008). The CC41 (Civilian Clothing 1941) scheme in World War 2 Britain and DIY (do-it-yourself) in US have a common factor and that is 'constraints in resources'. In particular the case of fashion in Britain around the Second World War, shows how the British society responded in a Jugaad way during wartime austerity concerns when faced with extreme resource constraints.

Post World War 2, post-industrialized countries adopted a more structured and protective innovation approach under abundant resources characterized by big budgets requiring R&D to deliver "more with more" and "bigger is better" (Radjou et al, 2012). Innovation was stereotyped as - the more you put in, the more you get of it. In 21st century, especially in emerging and developed markets, these assumptions of abundant resources are being re-evaluated leading to renewed global interest in historical Jugaad practices.

As stated its not a unique phenomenon that scholars identify today for Jugaad innovation. British society in 1940s was marked by austerity measures to assure necessary resources were committed to winning the war. But rationing meant diminished supply for the civilian population, many of whom affected were women and children. The government worried about escalating consumer prices, ends which risked not only societal inequality but also low public morale needed for winning the war.

The British Board of Trade introduced the CC41 utility scheme in 1941 to ensure quality consumer goods were available at reasonable prices. It was first introduced for clothes and later to furniture but the Jugaad principles learned and practiced extended to many consumer items. The civilian scheme forbade use of excessive material and of certain chemicals and materials like wool which were needed for military uniforms. Everything had to last as long as possible and being wasteful was considered detrimental

to winning the war. The scheme sought to bolster a 'make do and mend' Jugaad mentality which transpired in what was deemed good design and style, high efficiency and quality, yet affordable and accessible to all British segments.

In clothing, the CC41 austerity regulations introduced dress restrictions of no greater than five buttons, two inverted or box pleats or four knife pleats, two pockets, six seams in a skirt and no greater than four meters of stitching (Hull, 2011). However there were no fashion restrictions. Women improvised by turning drapes and bedding into clothes, pillowcases into white shorts for summer, and wedding dresses into French Knickers or nightgowns. Sometimes alternative materials were used and sometimes none at all by introducing novel substitution. Given rubber and leather was needed by the war effort, shoes were made with soles made of cork. And with nylon and silk needed to make parachutes, women improvised by painting their bare legs to simulate stockings (Rationing, 2011).

Since chemicals were in short supply, make up was unavailable, yet women felt the need to look beautiful as a morale booster. Jodie Kidd, the fashion model turned TV anchor narrates in the 2010 television show 'Ration Book Britain', women in the 1940s "put beetroot on their faces to make them look rosier and healthier.

But improvisation was not limited to use of materials. Fashion historians argue that although the utility clothing line was produced under strict regulations and first met with skepticism, the new fashion did not sacrifice style but rather redefined it (Schenk, 1994; Mendes, 1999; Mendes and De La Haye, 1999; Ration Book Britain, 2010).

But the CC41 scheme did not stop at clothes. Notwithstanding the rationing of timber, the government wanted the quality of furniture to be high, yet affordable and accessible to the majority of British consumers, particularly the newly-weds. Furniture design was standardized, mass produced in modular fashion, and delivered half completed to consumers with do-it-yourself (DIY) assembly directions. The CC41 affordable yet durable DIY furniture continued in popularity even when the scheme was lifted in 1952 (Ration Book Britain, 2010). This IKEA type furniture provided benefits that extended far beyond the circumstances that triggered it.

Jugaad in Modern Era

The contemporary contextual features of emerging markets as well as global austerity pressures in developed markets make Jugaad innovation particularly relevant, technologically feasible, and impact oriented. Although the relevance of Jugaad innovation relates to both emerging and developed markets, the circumstances in emerging markets are in particular useful to build a theoretical conceptual model for Jugaad innovation. This perspective adds to our understanding already developed through the historical account by additionally taking into account institutional voids and large populations as two contemporary challenges for Jugaad innovators.

Contemporary emerging markets are similar and also different from the contexts in which today's developed markets grew out from. They are similar in as far as the prevalence of resource constraints. They are however dissimilar in three ways - the types of resources available today, the notion of institutional voids, and the large population base of emerging markets. So current contexts in emerging markets offer a means for renewed interest in Jugaad innovation, but with increased means through leveraging lessons and technologies from the advanced countries and greater potential for impact with focus on achieving scale for the masses, i.e. 'for more people'.

Today in the emerging markets, resource scarcity also pervades as in Benjamin Franklin's 17th century USA or fashion during World War 2 Britain. But the USA or Britain then did not have access to the same stock of knowledge or leapfrog technologies as do today's emerging markets. The latter can learn from and acquire enabling technologies such as the Internet, wind, solar, and mobile telephony. Today's emerging markets are growing in very different ways from how the developed world grew out from (Govindarajan and Trimble, 2012; Radjou et al, 2012). One does not have to look far to see this – a hundred years ago developed countries used horse carriages, today's emerging markets such as India, primarily use motorbikes and rickshaws; historically telecommunication was in its infancy and limited to the most affluent, today the emerging markets have more mobile phone penetration than many developed markets. So while the emerging markets are in one sense facing resource constraints, but in another sense they can explore and exploit global technologies to leapfrog over and above legacy and aging technology systems in developed countries.

What is also different is that there is little evidence to suggest that institutional voids were recognized historically in developed countries the way they are recognized today in emerging countries.

In developed countries, sustainably providing basic services to all citizens is increasingly challenging. Global financial liquidity is low, public spending is slashed, public debt is at peak levels, natural resources are scarce and much in demand making them more expensive, and consumers are spending less.

Jugaad innovation in informal economies partly stem from doing good, but also from unmet gaps in the market (Economist, 2012). To reach the 'the next three billion', as Ernst and Young (2011) names this opportunity, means companies have to think differently about every stage in the new product development process to create entirely new products and services to fulfill unmet needs. For instance, GE is trying to disrupt itself by departing from a glocalization strategy to one of reverse innovation, which employs Jugaad innovation first in emerging markets (Immelt, Govindarajan, and Trimble, 2009). By shifting from a strategy where product comes first and country second and working the other way around, GE is trying to create new markets first in emerging countries and then in developed countries for new applications or segments (Immelt et al, 2009).

The Paradox of Size and Scale

The paradoxes of Jugaad in current times are many – Is it the large multinationals or small entrepreneurial firm who does more inclusive innovation? How do these two types of players compete, collaborate or co-opt in driving Jugaad innovation forward? The size of the company is a pending paradox in Jugaad innovation, which deals with driving of such Jugaad innovations. Driven by ambitions and persistence, social entrepreneurs especially of small entrepreneurial firms, have the ultimate motivation to innovate and implement inclusive innovation ideas. However, they face the constraint of resources in these ventures to typically up-scale their efforts in Jugaad innovation. On the other hand, large multinationals, lacks motivation to do so despite having abundant resources required to scale up and implement inclusive innovations. This scale and size paradox raises relevant questions regarding the suitability of the types of firms for Jugaad innovations especially to include the BoP in informal economies and developing nations. Does the collaboration opportunities exist between large and small firms, and if yes then, what should be the mode, method and process? Various schools of thoughts - Transaction Cost Economics, Resource and Knowledge Based View, Dynamic Capabilities, Game Theory and Real Options theory – may be instrumental in viewing these paradoxes and taking up further research on the same. These theories are likely to predict the effectiveness of collaborations between large and small firms and furthermore, identify the ideal situations when large firms will be more ventures and be successful in Jugaad innovation than smaller firms.

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400 Innovative projects showcased by IIT Delhi students

An electronic travel aid for the visually challenged, an intervertebral disc tissue using silk biotechnology and an e-health kit for rural paramedics. As many as 400 innovative projects - the result of hard work and bright ideas - were showcased by IIT Delhi students at the annual IIT Delhi Open House last week.... *Source: Hindustan Times – April 22, 2015*

Bio-inspired Liquid Lenses

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Lenses ranging from diverging to converging type are ubiquitous in optical devices such as cameras, telescopes, and microscopes. Typically, lenses used in optical devices are of fixed shape and therefore their focal length is fixed. Consequently, optical instruments leverage relative movement between fixed-focal length lenses to focus upon desired object. Such an arrangement results in bulky lens assemblies, which precludes their application for miniaturised optical systems such as those used in mobile phones and surveillance systems.

The nature however employs a different way of varying the focal length of lenses – by using deformable lenses. In sharp contrast to human-made imaging systems, animal eyes change the focal length by varying the curvature of lens while keeping the distance between lens and retina same. For example, the human eyes can attain a wide tuning range (10 cm to infinity) by changing the curvature of lens. Such tuning range and compactness is hard to achieve in human-made optical devices with fixed-focal length lenses. This has ushered growing interest in development of bio-inspired deformable lenses for miniaturized cameras such as in mobile phones where compactness and image quality are necessary [1].

The idea of using deformable lenses can be traced back to 1879 when Cusco, a French physician, developed a liquid-pumped optical system to determine refractive state of the eye. In Cusco's apparatus, each lens consisted of a thin glass plate separated from a spherical lens by a water-filled gap. The power of the lens system was varied by pumping water, which changed the curvature of glass plate. Although, the deformable lens design of Cusco was based on sound principles, brittle glass rendered the design unsuccessful back in time. An alternative design of deformable lens was proposed by Gordon in 1918. Unlike Cusco's design which employed varying liquid volume, Gordon's design used fixed liquid volume bounded by a flexible membrane. The change in curvature was obtained by pushing one side of the membrane into the fluid chamber which resulted in the other side of membrane to bulge out.

Modern liquid lenses can be classified into two types: pneumatic and electrowetting. Pneumatic type liquid lens works on principle similar to that of Cusco and Gordon's designs. In such lenses, fluid is kept in a transparent chamber having at least one optically clear elastic membrane as the chamber boundary. The curvature of the membrane is changed either by pumping liquid in or out of the chamber, or by increasing the pressure inside the chamber which deforms the elastic membrane [2]. Figure 1 shows a typical pneumatic type liquid lens. When the liquid is injected into the chamber, the increase in pressure causes the elastic membrane to attain a convex shape. Whereas, when liquid is removed from the chamber, the membrane attains a concave shape. Consequently, pneumatic type lens can be used for different lens configurations, including biconvex, biconcave, plano-convex, and plano-concave type. Moreover, these lenses have large tuning range. Another advantage of pneumatic type lens is that the lens profile is determined only by the mechanical properties of the elastic membrane. Therefore, the designer has greater flexibility in choosing the liquid of desired refractive index and dispersion properties. Besides using a pump to actuate the liquid lens, several other actuation mechanisms such as thermal, piezoelectric, electromagnetic, aperture size, and responsive hydrogel actuation have been demonstrated. At IIT Delhi, we are developing a mechanically actuated miniature liquid lens which can be integrated with commercial electronics such as webcams and mobile phones for enabling optical zoom feature.

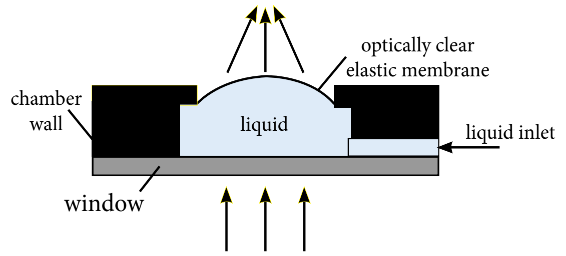

Figure 1: Schematic of a pneumatic-type liquid lens. The liquid is confined in the lens chamber having an optically clear elastic membrane as the top surface. When the liquid is pumped in or out of the chamber, the elastic membrane deforms producing a convex or concave lens.

The second type of liquid lens is based on the principle of electrowetting, that is, controlling wettability of a surface with an applied electric field [3]. The electrowetting phenomenon enables variation of contact angle of liquids on a non-conductive surface by applying potential difference between the liquid and the surface. The working principle of an electrowetting type liquid lens is illustrated in Figure 2. The lens consists of metallic electrode which is coated with a thin insulating dielectric layer. The lens chamber is filled with a conducting (water) and a non-conducting liquid (oil). Application of electric field between the metal electrode and conducting liquid results in a change in contact angle at the surface. Consequently, the curvature of liquid-liquid interface changes resulting a change in focal length. Electrowetting lens typically requires relatively high voltage of order 100 V. However, absence of any moving parts and fast switching speeds (of order of few milliseconds) make electrowetting lens favourable over pneumatic lens for applications involving fast time response. Besides the electrowetting lens design shown in Figure 2, several other configurations have been demonstrated. At IIT Delhi, we have successfully developed and characterised electrowetting liquid lenses which leverage electrowetting over transparent electrodes made of indium tin oxide for varying the curvature of liquid-liquid interface.

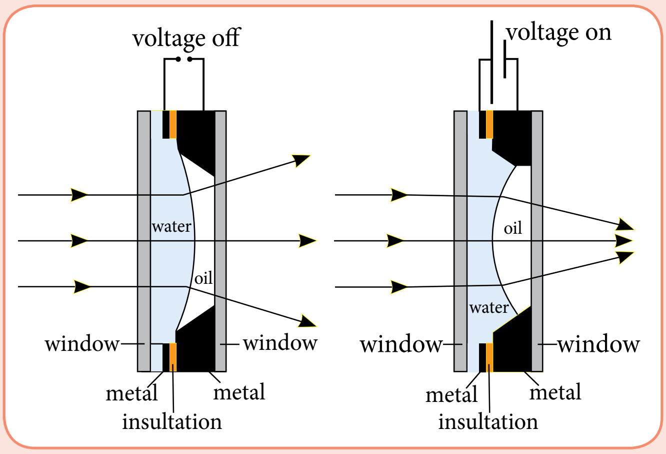

Figure 2: Schematic of an electrowetting-type liquid lens. In absence of applied voltage, the water-oil interface results in a concave lens. When voltage is applied, the metal electrode becomes hydrophilic resulting a change in contact angle at the electrode surface. As a result, the interface deforms to form a convex lens.

Liquid lenses are superior to traditional lens assemblies due to their light weight, faster adaptability, and compact design. Traditional imaging systems adjust zoom and/or focal length by changing the distance between individual lenses. They achieve this by use of motorized cams which consume more power and contain several mechanical components. Precise and controlled motions necessary in the fixed optical systems make them very expensive. On the contrary, similar objectives can be achieved by the adaptable liquid lenses while controlling the curvature of the liquid surface. Thus the fixed focal length and adjustable distance between lenses in traditional imaging systems is replaced by variable focal length and fixed distance between the lenses.

Optical advantages of liquid lenses extend beyond moving parts and cost. For example, the piezoelectric-actuated liquid lenses can have response time as small as 2 ms and its focus can tuned in the range of ∞-79mm [4] while having aperture sizes of order of few millimetres. The small aperture sizes and large tunability range can reduce the size of imaging systems without compromising on their robustness.

Additional fluidic advantages of using liquid lenses is the smoothness of immiscible liquid-liquid interfaces. Thus liquid lenses do not have any curvature defects unlike the traditional lenses which can have machining-induced curvature roughness. Moreover, diffusion at the liquid-liquid interface can be used to create controllable optical properties which are absent in conventional lenses. Liquids can easily be transported from one location to other, which can be used to change of liquid media in order to change the optical properties. For example, by changing the laser dye medium the wavelength of optical laser can be changed. It is also possible to renew the liquid lenses easily when the liquid gets deteriorated, an advantage which is not available to solid lenses.

We note that, imaging systems with liquid lenses do not vary from conventional systems as far as construction is concerned. However, unprecedented tuning range of liquid lenses can be utilized to design optical systems with unique functions. For example, liquid lenses can be used to create auto focussing universal imager, zoom lens, and surgical cameras [1]. Due to its favourable properties, liquid lens has a promise in replacing intraocular lens (IOL). The present day IOLs have limited ability to retain original accommodation capability inherent to human eyes. Unlike the fixed lens, ability of liquid lens to change its curvature using external power enables fluidic IOLs with tuning power five times more than IOLs. The concept of liquid IOL, as designed by Qiao et al is shown in Figure 3. Here, the curvature of fluidic IOL is controlled by external syringe.

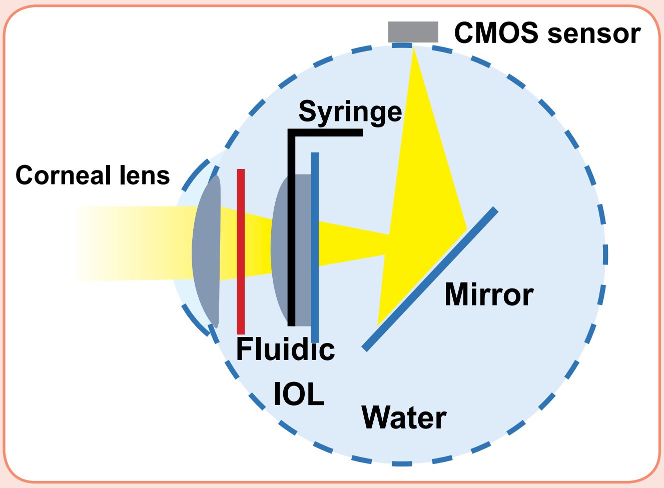

Figure 3: Concept design of fluidic IOL replacing the fixed lens IOL [5]. Advantage of fluidic IOL is that the external syringe can be used to control the curvature of fludic IOL and thus providing large accommodation range for an eye.

Despite the inherent advantages of liquid lenses, performance degradation of two immiscible liquids in a lens cell, hysteresis of contact lines at solid surfaces, and condensation of liquids at low temperatures impede their commercialisation. At IIT Delhi, we are currently working on addressing these challenges to improve the reliability and shelf life of liquid lenses.

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2

Faculty Profiles

Prof M Datta
Professor & Head
Department of Civil Engineering
Indian Institute of Technology Delhi

Improving the Engineering Practice for Containment of Solid Waste & Slurry Waste

Professor Manoj Datta was born in 1955 in the city of Jalandhar in Punjab. His early schooling was at Nangal and subsequently at Chandigarh. Prof Datta obtained his B. Tech (Civil Engg.) from IIT Delhi in 1977, with a Director's Silver Medal for standing first amongst the graduating students and then obtained his PhD degree from the same institute in 1980.

Prof Datta has been teaching and conducting research in the area of geotechnical and geo-environmental engineering for the last 35 years at IIT Delhi and is currently Professor and Head of Civil Engineering Department. He was Dean (Alumni & International Programmes) from 2004 to 2007 and earlier held the responsibilities of President, Board of Recreational & Creative Activities, Warden Jwalamukhi Hostel and Vice-Chairman (Estate & Works). He was on lien from 2008 to 2013 as Director, PEC University of Technology Chandigarh (a 94-years old institution earlier known as Punjab Engineering College which was upgraded to a Deemed University in 2004).

Prof Datta is a Fellow of the Indian Geotechnical Society. His research interests include the areas of soil mechanics, foundation engineering, ground engineering, earth dams, landfill engineering, environmental geotechnics and offshore geotechnology.

He has edited three books in the areas of landfills, solid waste management and ash ponds. He has co-authored a text book for undergraduate students titled "Geotechnical Engineering" with Prof SK Gulhati. He has published over 110 papers in journals and conferences and guided 8 PhD thesis and over 50 MTech thesis.

Prof Datta has been consultant to over 120 projects in the areas of geotechnical and geoenvironmental engineering and he has been the Principal Investigator/Co-PI for 6 sponsored projects funded by DST, ONGC, EU, HUDCO and others.

He has undertaken short visits to Stanford University, Harvard University and MIT in the US, Imperial College, Cambridge University and Cardiff University in UK, Tianjin University in China, IHE and TU Delft in Netherlands and Waterloo and McGill Universities in Canada.

Foundations of Offshore Structures (1980 to mid 90s)

Prof Datta's research work in the early 1980s, relating to the crushing behaviour of calcareous soils found off the coast of India, resulted in improvement of design methodology for pile foundations in such soils. This helped ONGC and EIL undertake rational design of piles for oil production platforms at Bombay High. Subsequently, research work into different types of foundations for floating offshore structures resulted in better understanding of engineering behaviour of anchors and superpile anchors and the development of suction beneath them during transient uplift load.

Environmental Geotechnics (mid 1990s till date)

Prof Datta and his group at IIT Delhi spearheaded the efforts to introduce the subject of Environmental Geotechnics in the post graduate curriculum of geotechnical engineering all across the country. The first Curriculum Development Workshop on this topic was held at IIT Delhi to develop the syllabus which was then circulated to all major PG Institutions. AICTE include this syllabus as an elective in their model curriculum on civil engineering. IIT Delhi became the first Institute in India to upgrade its MTech program from "Geotechnical Engineering" to "Geotechnical and Geoenvironmental Engineering". Prof Datta has been subsequently involved in holding several short courses and workshops on this topic for teachers of educational institutes and in helping central/state authorities in their efforts relating to planning, design, construction and remediation of waste disposal sites in India including HW landfills, MSW landfills, ash ponds, tailings ponds and contaminated sites.

Design Manuals & Guidelines

From 2000 onwards Prof Datta contributed technical inputs to the Ministry of Urban Development as well as Ministry of Environment and Forests and the Central Pollution Control Board for framing rules, design manuals and guidelines relating to disposal and containment of solid waste; he is the principal contributor to the following national-level manuals and guidelines published by them (these are followed by all municipalities and state pollution regulatory authorities in the country): (i) Chapter 17 (75 pages) on "Landfills" in "Manual on Municipal Solid Waste Management (2000)" Published by CPHEEO, Ministry of Urban Development; (ii) 4 manuals/guidelines on "Criteria For Hazardous Waste Landfills (2001)", "Manual for Design Construction and Quality Control of Liners and Covers for Hazardous Waste Landfills (2002)", "Alternate Coal Ash Transportation and Disposal Systems for Thermal Power Plants (2003)", "Guidelines and Checklist for Evaluation of MSW Landfill Proposals with Information on Existing Landfills", all published by Central Pollution Control Board, Ministry of Environment & Forests.

MSW and HW Landfills, Waste Dumps and Contaminated Sites

Prof Datta and his associates have carried out extensive research on liners and covers for solid waste facilities. They have been involved in improving the design, construction and monitoring of the first few well-designed Hazardous Waste Landfills which have come up in industrial areas across India including those at Ankleshwar, Gujarat (2002), Baddi, Himachal (2005), Kochi, Kerala (2006) and Dahej, Gujarat (2014). Prof Datta has also guided the efforts to close and remediate some of the 20m+ high Municipal Solid Waste Dumps of India including those at Gorai and Deonar, Mumbai (2005), Ghazipur, Delhi (2013) and Pirana, Ahmedabad and Urali Devachi, Pune (2010). Under the World Bank Aided project of MoEF on National Program for Rehabilitation of Polluted Sites, technical inputs have been provided for remediation of NMK Lake in Andhra Pradesh, closure of Dhapa MSW Dumpsite in Kolkatta and remediation of chromium contaminated sites in Hooghly District of West Bengal (2013-2015).

Ash Ponds and Mine Tailings Ponds

Prof Datta, along with his other colleagues, have done extensive laboratory work and field work on engineering behavior of coal ash and mine tailings. They have helped thermal power stations and mining companies in reducing the environmental impact and improving the stability of dykes of coal ash ponds at Rajghat and Indraprastha in Delhi, Ramagundam, Visakhapatnam, Bhatinda and Ropar as well as mine tailings ponds at Zawar, Rajpura, Dariba, Agnigundala, Hutti and Kudremukh.

Awards and Honors

Prof Datta has received five best-paper awards of the Indian Geotechnical Society – three IGS-ONGC awards, an IGS-AIMIL award and an IGS-Prof Dinesh Mohan Award. He was awarded the Indian Geotechnical Society (Delhi Chapter) Leadership Award in July 2008. He received the honour of being chosen as the Organizing Chairperson of the once-in-four-years global speciality conference "6th International Congress on Environmental Geotechnics (2010)" on behalf of the International Society of Soil Mechanics & Geotechnical Engineering (ISSMGE) and the IGS which was attended by 250 overseas delegates. He also received the honour of being invited by IGS to deliver the prestigious IGS Annual Lecture in 2011 at the Indian Geotechnical Conference at Kochi.

Gorai Municipal Solid Waste (MSW) Dump (2006)

Gorai MSW Dump – Remedial Measures Underway (2009)

Gorai MSW Dump After Engineered Closure (2012)

Institute lectures held...

Prof PB Mehta (Centre for Policy Research) on Foundation Day lecture, January 27

Prof D Bora (Director, Institute of Plasma Research) during his lecture on February 4

Prof S Roy
Department of Chemical Engineering
Indian Institute of Technology Delhi

Shantanu Roy is Professor in the Department of Chemical Engineering at Indian Institute of Technology Delhi, New Delhi. He holds a BTech from IIT Delhi (1994), and an MS(1996) and DSc(2000) from Washington University in St Louis, USA, all in the area of Chemical Engineering. Prior to joining IIT Delhi as full-time faculty member in 2004, he was employed at Corning Incorporated in New York.

Prof Roy's research interests include computational flow modeling of multiphase reactors, non-invasive imaging of multiphase flows, and process intensification through monolithic and structured reactor systems. In particular, he has been involved in the development and researching novel techniques like radioactive particle tracking (RPT) and different modes of process tomography and radiotracing in laboratory and industrial scales. These techniques help evaluate the velocity profiles and volume fraction profiles in complex, multiphase flow reactors and in addition to enhancing the fundamental understanding of such systems, also serve as unique and valuable validation data for computational fluid dynamics (CFD) based models of the flow. Knowledge of these flow fields provide crucial information for identifying transport-related inadequacies and inefficiencies in industrial reactors and help improve their design, scale-up and operational protocols. Prof Roy's work in this area of radiation-based flow imaging has been recognized by bodies like the International Atomic Energy Agency (IAEA), Vienna, which in 2007 developed a cooperative research program around some of the developments made by him in IIT Delhi.

Apart from his work on imaging of multiphase flow reactors, Prof Roy also works on several contemporary problems related to intensification of chemical processing in multiphase reactors, and improving the understanding of flow related problems in classical reactors. In particular, his work with process intensification in monolithic reactors has yielded several patents towards commercialization of monolithic substrates for three-phase reactor applications. Several governmental agencies like Department of Science and Technology (DST), Defence Research & Development Organization (DRDO) and BARC (BRNS) have been supporting research efforts in his laboratory. Prof Roy's practical research contributions has lead to several successful projects with national and international chemical and petroleum sector companies such as DuPont, Corning Incorporated, Air Products and Chemicals, Mangalore Refinery and Chemicals, General Motors, Thermax, Bharat Petroleum, MEMC Sun Edison, Engineers India Limited, BHEL, HPCL and Total.

Prof Roy was a recipient of the DuPont Young Faculty Award in 2004. He serves as an expert for International Atomic Energy Agency, Vienna for radiation-based experimental techniques and has lectured in several countries as an IAEA expert. Prof Roy also a member of the Scientific Advisory Committee of the Ministry of Petroleum and Natural Gas, Government of India, has served as a member of the Committee to formulate the National Auto Fuel Policy 2025. He also serves as a reviewer for several international journals and is on the editorial board of Advanced Powder Technology and the Asia-Pacific Journal of Chemical Engineering.

Abbreviations

AM: Department of Applied Mechanics,
BSTTM: Bharti School of Telecommunication Technology and Management,
CARE: Centre for Applied Research in Electronics,
CAS: Centre for Atmospheric Sciences,
CBME: Centre for Biomedical Engineering,
CES: Centre for Energy Studies,
CRDT: Centre for Rural Development and Technology,
CPSE: Centre for Polymer Science and Engineering,
CE: Department of Civil Engineering,
ChemE: Department of Chemical Engineering,
Chy: Department of Chemistry,
CSE: Department of Computer Science and Engineering,
DBEB: Department of Biochemical Engineering and Biotechnology,
DMS: Department of Management Studies,
EE: Department of Electrical Engineering,
HUSS: Department of Humanities and Social Sciences,
IDDC: Instrument Design Development Centre,
ITMMEC: Industrial Tribology,
KSBS: Kusuma School of Biological Sciences,
ME: Department of Mechanical Engineering,
Phy: Department of Physics,
TT: Department of Textile Technology

3 Happenings

Prof K Gupta, Department of Mechanical Engineering has been appointed as the Officiating Director of IITD with effect from June 19, 2015

Institute Lecture

Mr Jayant Sinha, Minister of State for Finance during a lecture program at IITD on April 23

Prof AK Ghosh, Prof N Bhatnagar, Prof P Mahajan, Dr MH Alai, Shri R Kumar & Ms P Singh have been conferred with National Awards For Technology Innovation In Petrochemicals for their work on "Multi- Functional Polymeric Orthotic Knee Joint for Polio and Cerebral Palsy Patients" under the category of Polymers in Public Health Care

Ericsson in Association with FITT

Ericsson Innovation Awards 2015: May 12

Industry collaboration with FITT

Collaboration with Power Grid Corporation of India Limited - June 30

JIPA in Talks with FITT

A high level delegation team from Japan Intellectual Property Association (JIPA) visited FITT on February 24

Tech Mahindra - March 10

Tryst 2015: Showcasing IITD's Innovations

Students displaying innovations during the technical fest on Feb 28

4 Innovations

Opportunities for IP Licensing

S No	Title	PI/Dept
1	Improved and simplified film cooling holes	Dr B Premachandran, ME
2	Diagnosis and prognosis of bearings for machine tool applications	Dr AK Darpe, ME
3	An innovative coiled flow inverted reactor for continuous refolding of denatured recombinant proteins	Prof AS Rathore, ChemE
4	Dual functionalized redox sensitive biodegradable polymeric nanosystem for targeted drug delivery in cancer therapy	Prof V Koul, CBME
5	Dual target redox sensitive biodegradable amphiphilic multiblock copymeric nanocarriers for cancer therapuetics	Prof V Koul, CBME
6	Portable device and disposable chip for immunomagnetic enrichment of target biomarkers	Dr RK Elangovan, DBEB
7	Magnetically separable nanostructure semiconductor photo catalyst for photodegradation of organic dyes	Prof N Khare, Phy
8	Method and system for noise reduction in CMOS image sensor	Dr M Sarkar, EE
9	An optimization free technique for determining concentration of the constituents of a mixture	Prof Jayadeva, EE
10	A method for using inter sysmbol interference for wireless communication security	Prof R Bose, EE
11	Controlled pattern formation on water surface	Prof AN Bhaskarwar, ChemE
12	Sensorless brushless DC motor drive with power factor correction	Prof B Singh, EE
13	A low cost process for production of snake antivenom peptide	Prof AS Rathore, ChemE
14	Sustained release of TB drugs and a process of its preparation thereof	Dr S Mohanty, ChemE
15	A method for continuous manufacturing of porous polymeric sheets and / or films	Prof N Bhatnagar, ME
16	A controlled release formulation and a method of preparation thereof	Dr S Mohanty, ChemE
17	A process for the preparation of Alkyl Ester of fatty acids	Prof MN Gupta, DBEB
18	A method of bio-harvesting and pre-treating algal biomass and uses thereof	Dr A Malik, CRDT

Tech Transfer @ FITT during Jan-Jun, 2015:

1) Concrete vibration sensor
2) High pressure water scrubbing

An Innovative Coiled Flow Inverted Reactor for Continuous Refolding of Denatured Recombinant Proteins

Prof AS Rathore
Department of Chemical Engineering
Indian Institute of Technology Delhi

In recent decades, the demand of biopharmaceuticals has increased manifold. This has induced a strong desire within the bioprocessing community to modify the current biotech unit operations to improve productivity and efficiency. Traditionally, biotech unit operations are carried out in batch mode, primarily due to the complexity of these process steps. However, over the past decade, the amount of protein that needs to be manufactured per year has been increasing. This is especially the case for monoclonal antibody products for which the dosage is significantly higher resulting in the need to manufacture tons of protein every year. For products such as these, continuous processing becomes more attractive due to the myriad of benefits it offers including lower shutdown costs, higher productivity, easier control and consistent product quality. Continuous upstream processing, commonly called perfusion, has been implemented and explored in the biotech industry for decades. However, continuous downstream processing and its integration is still awaited in the biotech industry.

The present invention involves use of a Coiled Flow Inverted Reactor (CFIR) for carrying out continuous protein refolding reactions in-vitro by dilution method. The reactor consist of an inline mixer followed by a design to provide cross sectional mixing of diluted denatured proteins through flow inversion thereby changing the direction of centrifugal force in helically-coiled tube. A novel coiled flow inverter (CFI) based plug flow reactor has been developed for continuous refolding of granulocyte colony stimulating factor (GCSF), a biotech therapeutic product. This configuration effectively provided substantial cross sectional mixing while maintaining a favourable distribution of residence time. **It has been demonstrated that enhanced mixing in CFI allows for operation at higher protein concentrations (0.38 mg/ml as compared to 0.19 mg/ml in batch) and results in comparable purity (84% vs. 83% in batch), thereby resulting in a significant reduction of costs related to downstream purification.** In addition the configuration proposed here does not require the large tank that is otherwise required for dilution based batch refolding. The proposed configuration is likely to perform favourably in other biotech unit operations that require mixing and/or sharp residence time distribution such as precipitation.

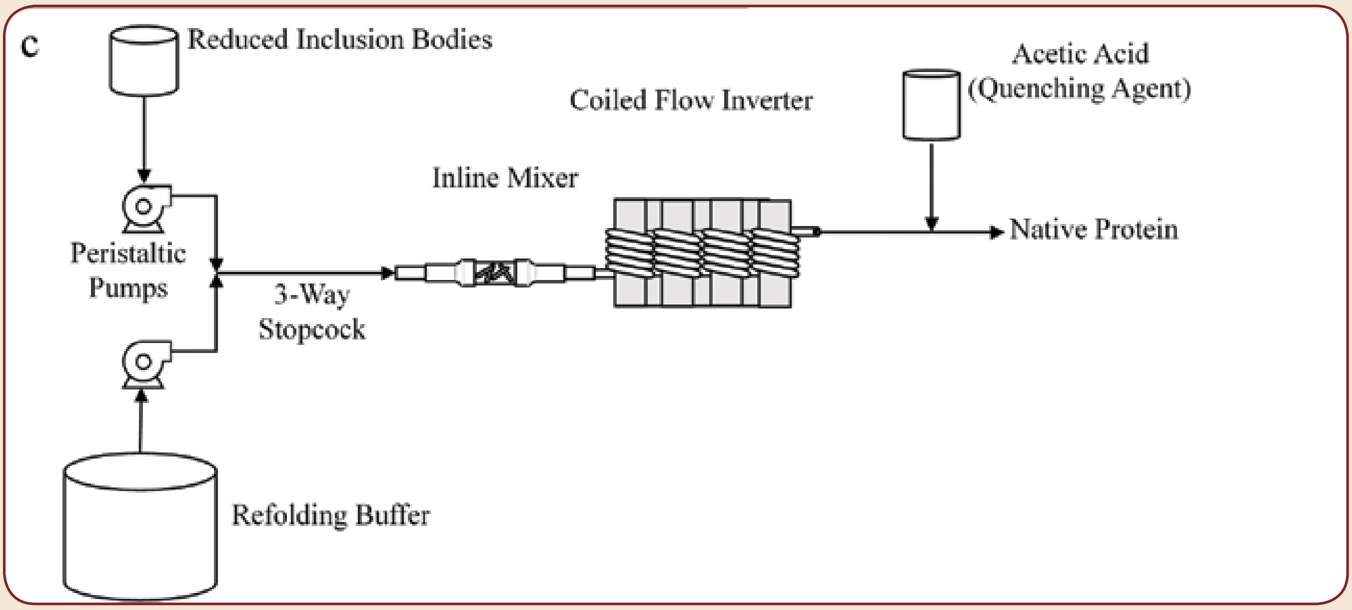

Figure 1: Process flow diagram for the continuous refolding process. A bank is a collection of four branches, each with five turns of helix.

BIRAC Announces 7th Call for Proposals under the Biotechnology Ignition Grant (BIG) Scheme

Under the Biotechnology Ignition Grant (BIG) Scheme of BIRAC where FITT is a partner, submission of proposals is invited from July 1 to August 14, 2015.

Stimuli Responsive Biocompatible & Biodegradable Polymeric Nanosystem for Cancer Therapeutics

Prof V Koul
Centre for Biomedical Engineering
Indian Institute of Technology Delhi

Cancer is among leading causes of death worldwide and is considered the second most deadly disease after cardiovascular diseases. Conventional cancer chemotherapy suffers from several drawbacks such as non-specificity causing severe side effects and multidrug resistance. The cancer cells are characterized by various intrinsic stimuli such as pH, redox and temperature. This stimulus makes them sensitive to release the loaded drugs in a controlled manner. Our laboratory at CBME has been working on the development of various type of stimulus so that the release of drug could be controlled either by single or multiple stimuli and it allows achieving higher bioavailability of drug, to overcome multidrug resistance and to reduce side effects of chemotherapy in order to improve the life of cancer patients.

The present invention provides a design and fabrication of dual functionalized redox responsive biodegradable polymeric nanocarriers with high therapeutic payload of anticancer drug for targeted drug delivery in cancer therapy. More particularly, the present invention provides a nanosystem with **redox sensitivity, dual targetability, biodegradability and scalability for improving chemotherapeutic efficacy** of doxorubicin with **reduced cardiotoxicity** in breast cancer therapy. Redox sensitivity will prevent drug release during circulation but will allow drug release in endo-lysosomal compartment with high glutathione concentration in cancer cells. PEGylation imparts stealth nature to the nanoparticles, helping them to escape macrophage recognition resulting in enhanced circulation half-life. Active targeting of nanoparticles will ensure specific targeting of nanoparticles to cancer cells while sparing normal non-cancerous cells from cytotoxic effects of drug. These biocompatible smart polymeric nanosystems have shown potential as a therapeutic carrier for targeted drug delivery in cancer therapy and shows promise to be translated from preclinical to clinical settings. The picture presents one of the systems.

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1. Shantanu V. Lale, Arun Kumar, Shyam Prasad, Alok C. Bharti and Veena Koul, Folic acid and trastuzumab functionalized redox responsive polymersomes for intracellular doxorubicin delivery in breast cancer, Biomacromolecules, 2015; 16: 1736-1752.
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3. Shantanu V. Lale, Arun Kumar, Farhat Naz, Alok C. Bharti and Veena Koul, Multifunctional ATRP based pH responsive polymeric nanoparticles for improved doxorubicin chemotherapy in breast cancer by proton sponge effect/endo-lysosomal escape, Polymer Chemistry, 2015; 6: 2115-2132.
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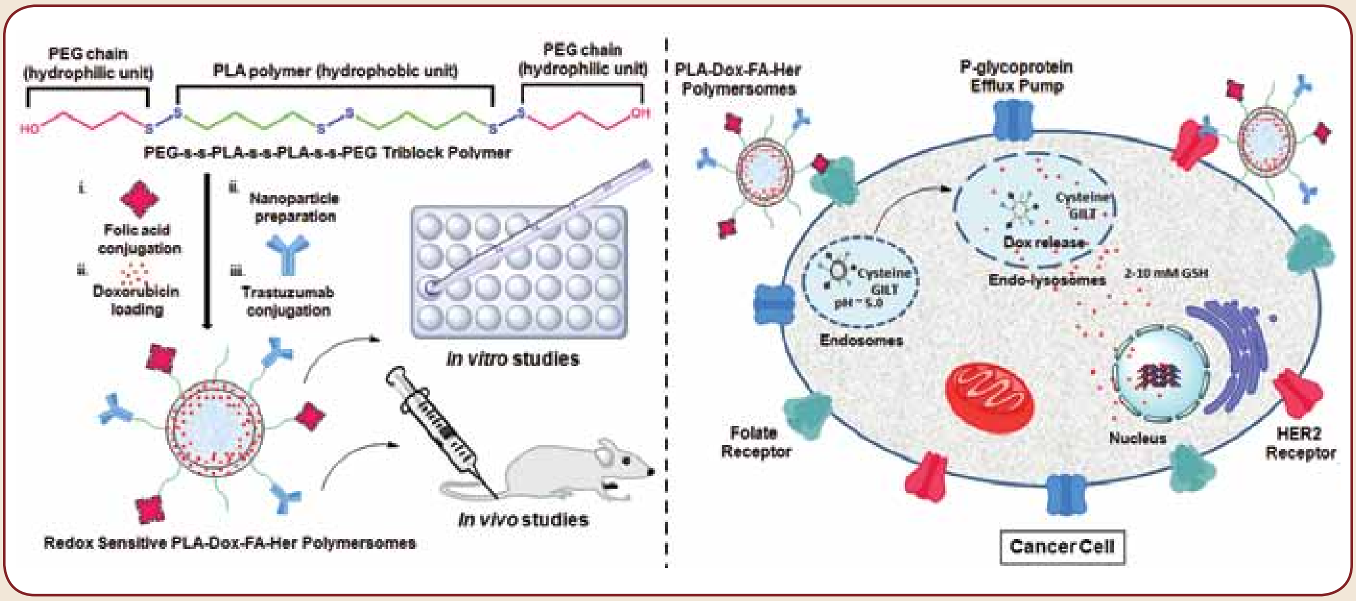

Examples of Development Projects @ FITT

S No	Title	PI/Dept
1	Reducing the temperature rise of electric motor bearing without the use of forced convention	Prof H Hirani, ME
2	Advice for development of long term monitoring techniques using underwater acoustic technology (Phase-VI)	Prof R Bahl, CARE
3	Prepolymer development and evaluation	Dr J Jacob, CPSE
4	Kit in alternative designs	Dr J Kumar, IDDC
5	Planning and design of Rohini heliport for M/s Pawan Hans	Prof A K Keshari, CE
6	Treatability study for the removal of chloride from Gelatin industry waste waters – Phase-III	Prof T R Sreekrishnan, DBEB
7	EEG Signal based recognition Module with low computational load	Prof Jyadeva, EE
8	Algorithmic framework for MEMS sensor fusion applications (Phase-I)	Prof A Kumar, CARE
9	Development of Aqua-System® based processes to treat different water feeds to achieve output of specified quality	Prof R Khanna, ChemE
10	Development of Aqua-Correct® based processes to condition water to increase solubility of Calcium and Magnesium Carbonates and Sulphates	Prof R Khanna, ChemE
11	Investigation of fatigue loads on reinforcement bar mechanical splices	Dr J Jain, AM
12	Power modelling and optimization	Prof P R Panda, CSE
13	Feasibility study and development of initial model for fuel efficient and eco-friendly urban light commercial vehicles	Prof PMV Subbarao, ME
14	Use of Membrane Chromatography for purification of Monoclonal Antibody Therapeutics	Prof AS Rathore, ChemE
15	Reduction in unlevel/off-target dyeing of wool year to minimize redyeing/rejection	Dr BS Butola, TT
16	Alcohol based biofuel study in Spark Ignition Engine	Dr KA Subramanian, CES
17	Logo and user interface development for televisory system	Dr J Kumar, IDDC
18	Developing low cost environment-friendly technological solutions for six selected handicraft clusters of Varanasi, Lucknow, Jaipur, Churu, Kota and Udaipur	Prof R Chattopadhyay, TT
19	Exploration of Novel Application for Monolith Substrates	Prof S Roy, ChemE
20	Testing of adhesion propensity of cells and extracellular matrix proteins to the surfaces with biomaterial coating	Dr S Deep, Chy
21	Hardware design of a low cost Bluetooth based indoor tracking device	Dr B Lall, EE

Forthcoming HRD Program - 2016

International Conference - Biomaterials, Biodiagnostics, Tissue Engineering, Drug Delivery and Regenerative Engineering from April 15-17, 2016 - Participation fees based.

5 Snippets

Corporate Membership of FITT

FITT invites the industry/industry associations/R&D organizations and financial institutions to become corporate members of FITT at a nominal annual subscription. A corporate client can participate in technology transfer and joint R&D programmes of the Institute on a priority basis with FITT providing the interface. Membership form can be downloaded from www.fitt-iitd.org

New Corporate Members:

1. Trident Ltd
2. Ingersoll Rand International (India) Ltd
3. Napino Auto and Electronics Ltd
4. Rohm Semiconductor India Pvt Ltd

Professional Candidate Registration Programme

Applications are invited from qualified professionals working in industry and research organizations for a unique knowledge augmentation and skill enhancement programmes at IIT Delhi. This involves a semester-long registration for a regular PG course. Course fees ranges from Rs. 15,000/- to Rs. 20,000/- (industry professionals) and Rs. 6,000/- to Rs. 8,000 (academic/government personnel) for a 42 hour lecture course. In the case of a few selected courses, on-site course delivery using the two way audio-video link can be considered. All major disciplines of Science and Engineering, and also relevant courses from the Humanities, Social Sciences and Management streams which are being conducted at IIT Delhi are covered. The course detail can be downloaded from FITT website www.fitt-iitd.org. Eligibility: Degree in Engineering or Masters Degree in Science, Management or any other Post Graduate Degree with relevant industry experience. The two semester sessions in the academic year starts in the month of July and January, the exact dates being notified in advance. Contact: uttamaswal@hotmail.com, kirityroy@yahoo.com

News and Views

Innovation needs protection

Sunday was World Intellectual Property Day. This year's theme–Get up, stand up. For music–is a tribute to the pioneering legacy of reggae musicians Bob Marley and the Wailers, whose song *Get Up, Stand Up* and others called for civic action to address injustice. But although Marley and the Wailers' music inspired generations, their message built on the well-known principle taught to us by Mohandas Gandhi, Martin Luther King Jr and others, that all must act to right great wrongs. But even though this message was well known, *Get Up, Stand Up* contributed to humanity's artistic and intellectual growth by speaking to us in a new way. For this reason, the song deserved the full protection of intellectual property rights (IPR). *Source: Mint- April 26, 2015*

IITs are a hotbed of innovation: Chris Houghton

Ericsson Innovation Awards were initiated last year in association with the Foundation for Innovation and Technology Transfer (FITT) to recognise the spirit of innovation among students across seven IITs in Chennai, Delhi, Kanpur, Kharagpur, Mumbai, Roorkee and Banaras Hindu University (BHU) in Varanasi. Projects from IIT Delhi and IIT Roorkee were selected this year for the awards. "The rapidly rising ubiquity of mobile phones and broadband in India is fuelling innovation as never before," Chris Houghton, head of India Region, Ericsson told Sudhir Chowdhary in a recent interaction. *Source: The Financial Express - May 24, 2015*

Innovation from India is helping customers across the globe: Vijay Mhaskar, Avaya

A few years back, Avaya was largely known as a call center connectivity company. Over the last couple of years, the communications company from California has evolved as a software infrastructure company. Its India development centers have played a big role in this evolution. Vijay Mhaskar, who heads Avaya's R&D centers in India, tells ET how India is defining the company's journey, and how difficult it is to stay relevant in a continuously disruptive market. *Source: The Economic Times - June 12, 2015*

Made-to-order heart to aid surgeons

Washington June 29: Researchers, including one of Indian-origin, have successfully produced the first 3-D anatomic model of a patient's heart using two common imaging techniques, aiming to enhance diagnosis and surgical planning.

The 3-D model printing of patients' hearts has become more common in recent years as part of an emerging, experimental field devoted to enhanced visualisation of individual cardiac structures and characteristics. *Source: Business Line - June 30, 2015*

We Value Your Feedback

FITT seeks to explore various avenues to enhance the quantum of interaction between industrial units/end-users and IIT Delhi. Therefore, we keenly look forward to your feedback and suggestions on various issues that can help meet our objectives.

Write: mdfitt@gmail.com.

Feedback

LEADERSHIP

FITT

1. Prof K Gupta, Director IIT Delhi, Chairman
2. Dr A Wali, Managing Director
3. Mr KK Roy, Chief Operating Officer

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