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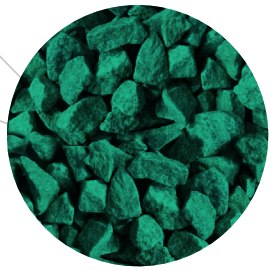
Driving Start-up India

India or its cities sparsely figure in the top league of world rankings with respect to the start-up ecosystem or as a top destination for new age entrepreneurs. Its early entrepreneurial origins notwithstanding, India is lagging behind even some smaller Asian countries. However, the start-up India mission articulated by the central Govt. in 2016 is expected to boost the ecosystem in the country by drawing in more entrepreneurial energy. Towards this, the policy initiatives have to be matched by equally rigorous changes on ground – ease of doing business, easy access to capital, availability of talent and mentorship, level-playing business field, efficient networks of stakeholders, availability of fab-labs / workshops, minimal bureaucracy, benign tax regime etc. Thanks to proactive Govt. agencies, the country is seeing robust attention to establishment of incubators and other similar set-ups. And, interestingly, the entrepreneurs are not shy of addressing the market-place pain points and the societal challenges through innovative solutions. Given the scale of our challenges, the number of disruptive ideas are not too many. Even the quantum of intellectual properties being generated need to be enhanced by academia and research organisations to provide a robust pipeline of ideas to innovators and entrepreneurs. A large base of research translation creates the necessary pull effect. Besides, the private sector has to chip in more than mere CSR contribution, and scale-up the partnerships to be recognised as an important stakeholder. Effective engagement with industry facilitates smoother go-to-market and growth efforts. To figure among the top in the world, the benchmarks are steep but, not difficult to accomplish. While suitable public-private-partnership models can be adopted and scaled to strengthen the domestic ecosystem, unique internationalization programs opportunities also need to be created to enhance the start-up outreach and build similar capacities and capabilities internally. The creation of several unicorns by the alumni of leading academic institutions like IITs attests to the importance of entrepreneurial universities. Such successes can be the role models that would drive the passion and unleash the entrepreneurial instincts – both of start-ups and organisations and, thus become an engine of substantial socio-economic growth that would catapult us in various global rankings.

Anil Wali

What's inside



Tech Tales...

Image-based shape characterization of granular materials

Prof P Vangla
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Introduction

Granular materials hold significant importance to the global economy, society, and environment. Granular materials serve as the elementary building materials from which many advanced high-performance products are fabricated in the industries. The usefulness of granular materials spans a range of industries that include chemical, petrochemical, agricultural, food, pharmaceuticals, mineral processing, civil engineering, advanced materials, and energy. The diverse and intrinsic nature of granular materials poses several challenges in its manufacturing, handling, and processing techniques. Hence, an understanding through accurate quantification of the properties such as size and shape of these materials is an essential requirement in process design, process performance evaluation, and troubleshooting.

In the field of geotechnical engineering granular materials such as, pebbles, gravels, sands, silts, and clays with different sizes and shapes are often used for various applications. In different contexts, several researchers have emphasized that the size and shape of soil particles hugely influence several geotechnical engineering properties such as limiting void ratios, shear strength, permeability, and compressibility. However, the complexities involved in obtaining the geometrical parameters necessary to compute particle shape adequately have hindered the clear understanding of the contribution of particle shape to such properties. Several researchers have attempted to characterize the particle shape of sand particles by various methods including projection methods, standard shape comparison methods, functional methods and fractal methods (Sozer, 2005), which led to the evolvement of many shape parameters/descriptors. Despite the availability of many methods, no method has been accepted as standard, because of conceptual and practical deficiencies. Historically, shape analysis of the granular materials was carried out mostly by visual inspection. There are several studies (Mackie, 1897; Powers 1953), which provide reference images of granular materials for the qualitative estimation of the roundness through visual observations. ASTM D2488-09a also provided the images of typical angular bulky grains to describe the angularity/roundness of coarse grained particles visually. However, methods based on a visual inspection and mathematical formulae suffer from many criticisms; former methods include ocular inspection of shape parameters of particles based on visual reference charts, which are more prone to user dependent results latter methods are tedious and challenging to implement on a large number of particles. The recent developments in the imaging technologies are enabling researchers to deviate from the conventional methods (visual inspection and formula based) move towards developing a new and efficient image-based size and shape characterization methods in terms of accuracy and rapid characterization. This would facilitate micromechanical analysis at the particle level and provide useful insight into the complex behavior of particulate materials.

Methodology

According to the sedimentologists, the particle shape comprises of three different multi-scale components - sphericity (macro-scale), roundness (meso-scale), and surface texture (micro-scale). Sphericity is used to describe the overall shape of the particle, roundness is independent of sphericity and refers to relative sharpness of the corners and edges of the particle. Surface texture is used to describe the micro level surface features that exist on the particle, which are too small to affect the overall shape. Barrett (1980) study classified all three components of particle shape (mostly independent properties) - form, roundness, and surface texture into three different scales to the particle size, as shown in Figure 1a. These three levels of shape features can also be represented along the open particle outline, as shown in Figure 1b, c, where the form component is superimposed on the open profile of the particle boundary and the roughness component is superimposed on the waviness component of the particle, respectively.

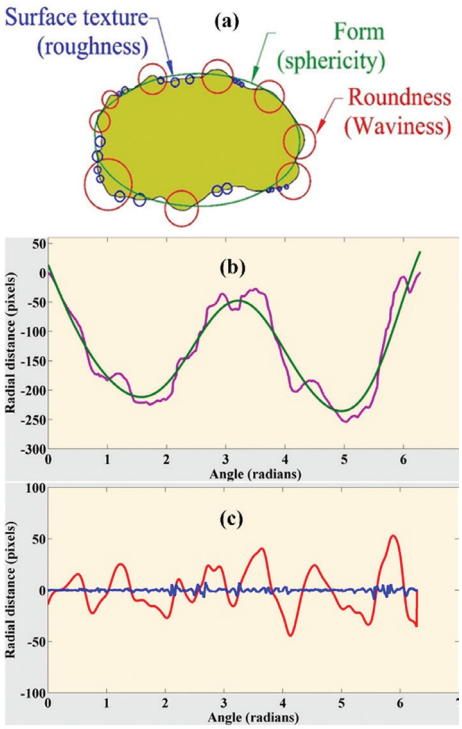

Figure 1: Schematic of (a) Bubble aerator, (b) Spray aerator. Blue and white color indicates water and air respectively. Black arrows indicate the direction of flow.

To characterize the three components of the particle shape, often many researchers use the information of the particle obtained from a 2D image. There are variants of methods proposed by many researchers to characterize the particle shape, which requires either geometrical information or particle area information. The information regarding particle geometry such as length, breadth, perimeter, and area can be easily obtained by computerized image processing techniques used to analyze images. In this

study, a new computational method based on a combination of Fourier descriptor analysis, filter techniques, and computational geometry is implemented smoothly and efficiently, to quantify the classic shape parameters (sphericity, roundness, and roughness) of two-dimensional projection of granular particles. In addition to this, the precise detection of the corner and non-corner regions along particle outline is used to propose new parameters for effective understanding of the kinematic behavior of granular materials (for more details refer Vangla et al., 2018). The proposed method is implemented in three parts in MATLAB. The first part involves applying filtering techniques on segmented images to remove high-frequency components of noise and roughness after converting the boundary profile of the image into a frequency domain using Fourier Transforms. The above process can be used to quantify roughness of the particle outline as well as to obtain roughness-free boundary for the computation of roundness and sphericity. The second part encompasses the implementation of an algorithm to identify 'corners' along the particle outline free from microscale features and to fit the most appropriate circle in each corner. This information aids in the quantification of roundness as coined by Wadell (1932), which is considered more statistically sound and widely accepted. The third step deals with the quantification of the form or sphericity of the particle using computational geometry. The operations are performed on binary images obtained from raster images (collection of pixels) by the process of image segmentation. Image segmentation technique converts a colored/grayscale image into a binary image and creates an easier platform for analysis since the binary image consists of only two colors (white and black). For more details of the algorithm, refer to Vangla et al. (2018).

Application of proposed methodology

The proposed method is capable of quantifying the shape parameters of a single particle and group of particles as shown in Figures 2 and 3 and Figure 4 respectively. It is also capable of characterizing any granular materials falling across a wide range of sizes, shapes, and mineralogy. To demonstrate these facts, the method proposed is implemented on selected particles of different mineralogy as shown in Figure 2 and from four groups: River Sand (RS: particle size 0.075 – 4.75 mm), Quarry sand (QS: particle size 2 – 4.75 mm), Crushed Gravel (CG: particle size 4.75 – 63 mm) and Pebble (PB: particle size 4.75 – 63 mm) as shown in Figure 3. The specific size fraction of Quarry sand (QS) is scalped after being obtained from a local quarry. Gravel particles belonging to the category CG are also obtained from a local quarry, whereas particles belonging to the category PB are naturally rounded pebbles. Figure 2 and 3 also demonstrate that the proposed image-based method can work on any images captured with different sensors. RS particles were captured using Scanning Electron Microscopy (SEM) and Microscope and other particles shown in Figure 2 and QS, CG, PB as shown in Figure 3 were captured using a High definition camera. Hence the proposed methodology is capable of classifying all kinds of real granular materials. The images of particles are taken with their maximum base area resting on the ground to ensure a two-dimensional projection image of maximum base area/most stable position. The magnification of all images is chosen in such a way that pixels per particle length is higher than 500 to ensure the elimination of resolution effect on the shape parameters as discussed earlier.

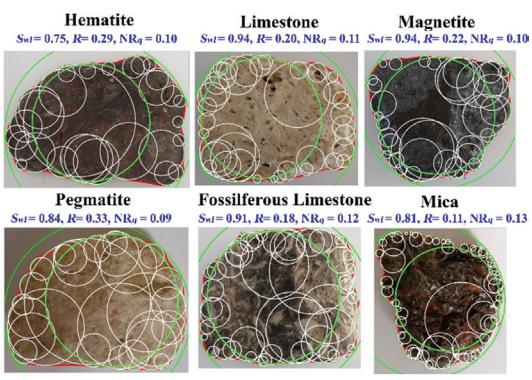

Figure 2: Shape analysis of real particles of different compositions

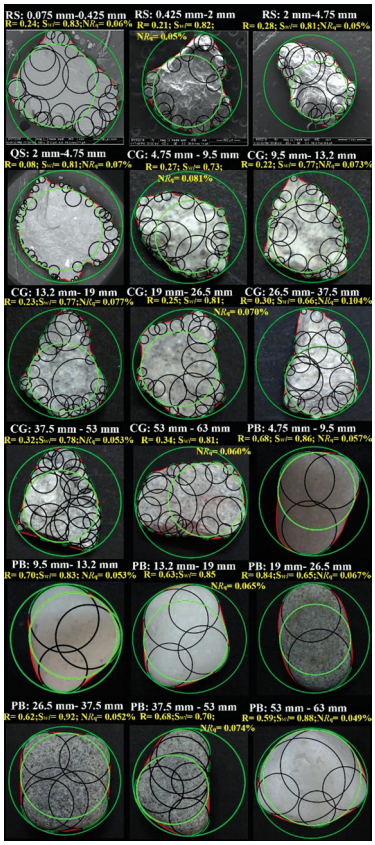

Figure 3: Shape analysis of real particles of different sizes and shapes

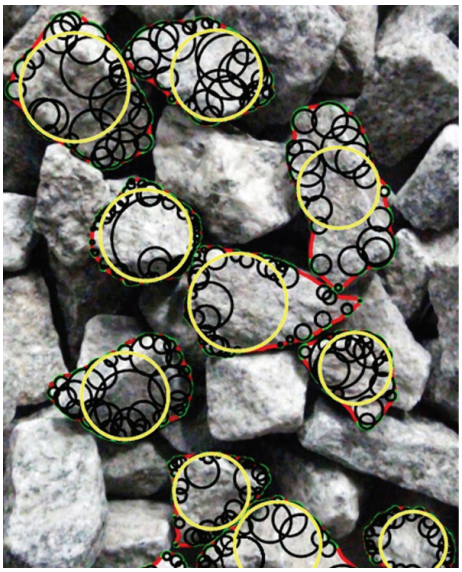

Figure 4: Implementation of proposed method on a group of particles.

Dr. Vangla's research team is currently working on developing image-based methodologies for obtaining size distribution and 3D shape characteristics of granular materials. The evolution of digital technology has also led to the development of advanced 3D image methods coupled with mathematical models, such as X-ray tomography, laser scanner, and X-ray microtomography for shape characterization.

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Innovation Adoption Frameworks and their Applicability in the Information Age

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Abstract

The Technology Acceptance Model and the Theory of Planned Behavior have demonstrated pioneering research efforts within the scholarly domain of innovation adoption concerning new technologies. This article briefly reviewed the applicability of these frameworks within the context of emerging technologies of the information age. It can be safely concluded that both are widely used and applicable to various emerging technologies and continue to remain instrumental in the research domain of innovation adoption.

Keywords: technology acceptance model; theory of planned behavior; emerging technologies; innovation adoption; innovation, and society.

Introduction

Two theoretical frameworks, Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB), serve as the foundation of technology adoption studies within various contexts. TAM is a widely utilized theoretical framework for the assessment of how people make decisions regarding new technology adoption. TPB is highly recognized and significantly used in marketing research studies (Ajzen, 1991). Therefore, both TAM and TPB are useful when a study focuses on the potential adoption of emerging technology.

Technology Acceptance Model

The goal of TAM is to predict user acceptance and highlight potential design issues before users of the technology interact with the system (Dillon & Morris, 1996; Mohd, Ahmad, Samsudin, & Sudin, 2011). TAM was developed with support from IBM Canada and is rooted in the underlying psychological theory known as the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980). As shown in Figure 1, TAM demonstrates a framework for explaining behavioral intentions and the actual behavior of users for new technology adoption.

Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are the perceptions of the beliefs users hold about the system (Dillon & Morris, 1996). Davis (1989) defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" and PEOU as "the degree to which a person believes that using a particular system would be free of effort" (p. 3). The original study of TAM generated six highly reliable items for both PU and PEOU.

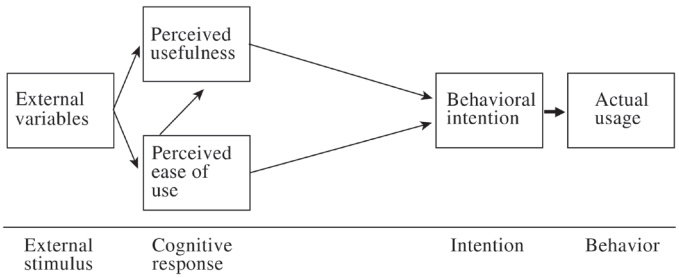

Figure 1: TAM model. Adapted from Davis & Venkatesh, 1996, p. 20

Theory of Planned Behavior

This theory was an improvement upon the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980), which looked at predicting individual behavior in volitional situations (Sparks & Shepherd, 1992). TPB focuses mainly on predicting planned human behavior and incorporates the construct of perceived behavioral control (Li, 2010; Montano & Kasprzyk, 2015; Sparks & Shepherd, 1992). The literature has presented sufficient evidence that TPB has an enhanced capability of predicting behavioral intention by adding the perceived behavioral control construct (Madden, Ellen, & Ajzen, 1992).

When individuals have time to plan for their behavior, to predict their behavior, we need to understand their intention towards performing that behavior (predictor), which is the summation of Attitude, Subjective Norms, and Perceived Behavior control constructs as shown in Figure 2. Also, if two or more of these constructs are not supporting the behavioral intention, then the likelihood of actually performing that behavior decreases significantly.

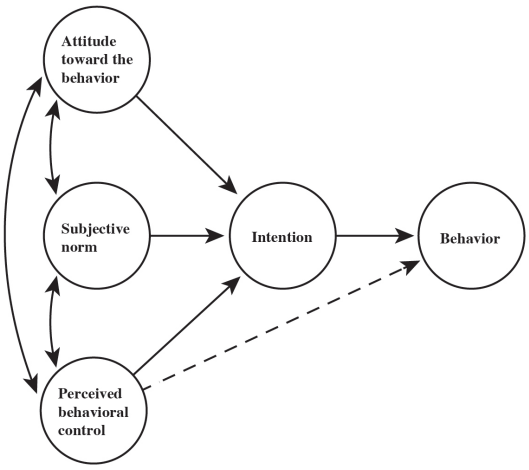

Figure 2: Theory of Planned Behavior model.
Adapted from Ajzen, 1991, p. 182

Attitude: This construct is an individual's own opinion about a given situation. This opinion is formulated through self-analysis gathered via an individual's behavioral beliefs and outcome evaluations (Mathieson, 1991). Attitudes are found to be positive or negative (Agarwal, 2000; Orbell, Hodgkins, & Sheeran, 1997).

Subjective Norms: This construct constitutes the external societal forces acting upon an individual (Agarwal, 2000; Mathieson, 1991; Orbell et al., 1997), such as cultural, referent, and group elements.

Perceived Behavioral Control: This construct reflects if an individual is faced with a difficult or easy task for a given situation (Agarwal, 2000; Orbell et al., 1997) and can be dependent on the available skills and resources required to formulate behavioral intentions (Dillon & Morris, 1996).

Emerging Technologies as Applications of TAM and TPB

With the increase in technological dependence in our lives and global socio-economic interdependence, several researchers associated with academia and industry have been actively involved in studying consumers' adoption intentions of various technologies (Arts, Frambach, & Bijmolt, 2011; Kulviwat, Bruner, & Al-Shuridah, 2009). Figure 3 below shows the consolidated model representing a literature overview on various applications of TAM and TPB.

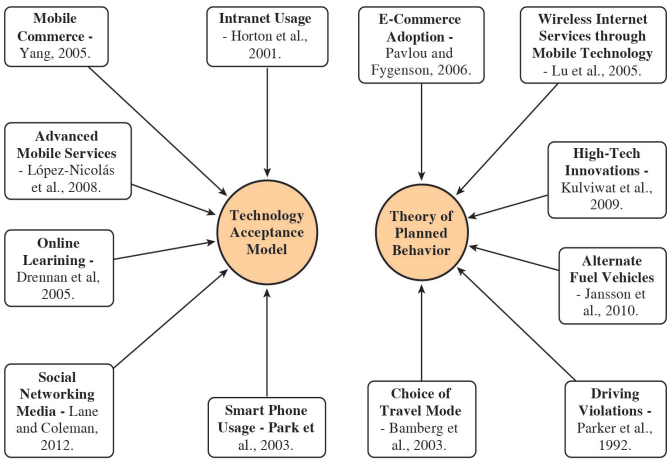

Figure 3: Model depicting various applications of TAM and TPB.

Final Remarks

Research within the field of innovation adoption often presents a challenge regarding the scarcity of similar studies and consumers' innovation inexperience (Cooper, 1998). The dynamics of the relationship between humans and automation is critical to the performance and survival of emerging technologies (Ghazizadeh et al., 2012). Both TAM and TPB will continue to serve as the fundamental means for researchers seeking to study the factors influencing consumers' adoption intentions of various technologies. The literature reveals a wide variety of applications for both of these frameworks across multiple cultures, geographies, and different contexts.

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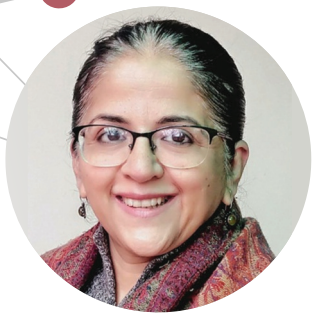


Faculty Profiles

Prof D Gupta
Department of Textile Technology
IIT Delhi

Dr Deepti Gupta is a Professor in the Department of Textile Technology at IIT Delhi since 2012. She completed her PhD from the same department in 1995 and joined as an Assistant Professor in 1997. Her research interest is primarily in the area of textile chemical processing, functional clothing and product design.

Prof Gupta's interest in the broad area of ecofriendly processing of textiles developed while she was working on her Master's thesis on application of natural dyes on textiles. She further explored in depth, the process of purification and characterization of natural dyes as well as the theory of dyeing textiles with these dyes during her doctoral research. On the application side, she conducted workshops in several parts of the country to train traditional dyers in scientific methods of dyeing wool, silk and cotton with optimized methods of dyeing with natural dyes and co-authored one book on the subject.

Subsequently, she expanded her work by evaluating and establishing the pharmacological properties (antimicrobial, anti UV, antioxidant) of natural dyes and other natural, renewable materials. She developed technologies for use of chitosan (from shells of crustaceans) and sericin (from silk cocoons) as multifunctional finishing agents for textiles, under research projects sponsored by Department of Biotechnology. Technology for sericin based textile finishing is currently being commercialized by an online garment retailing company. While working with antimicrobial finishes, she got interested in the little studied area of microbial abundance on healthcare textiles in India. Currently, she is engaged in studying textile-microbe interactions under an interdisciplinary project with department of Biomedical Engineering and Biotechnology.

Prof Gupta was invited to set up and head the department of garment technology at Technological Institute of Textiles, Bhiwani, during 1993-1995. This was the beginning of her interest in the then fledgeling field of Garment technology. When she joined the department of Textile Technology at IIT Delhi in 1997, department's activities were limited to textile technology. Recognising Garment technology as a natural extension of department activities, she was entrusted with the responsibility of initiating teaching and research activity in this area. She has since developed and taught courses on Garment Technology and functional clothing at the department. On the research front, she studied the anthropometric characteristics and proposed a garment sizing system for Indian population. During this time, she had the opportunity to interact with most apparel brands and gain an understanding of the problems of garment sizing in India. The learnings have been recorded in the two editions (2014 and 2019) of the book on "Anthropometry, Garment Sizing and Design" co-edited by her and published by Elsevier.

When the institute introduced a mandatory course on Textile Product development (TTP 200) in the UG curriculum in 2004, Prof Gupta got involved with the teaching and development of this new course. She created a unique model of teaching-learning for this course which became very popular amongst students. Several interesting products were developed and a patent filed for a product emerging from the course. When the Design and Innovation activity (DIC) was initiated at IITD, she was invited to be a part of the interdisciplinary faculty group involved in mentoring the activity. She is also a founding member of the Department of Design at IITD.

As a result of her involvement with product design activities, she was approached by senior consultants from AIIMS during 2014-2015 to develop textile based products needed for support/rehabilitation of vulnerable groups. She, along with her team, has since developed several medical products including Mama Pod which is a life saving jacket recommended by WHO for support of low birth weight babies. After undergoing clinical trials at AIIMS Delhi and St. John's hospital, Bangalore, the technology has been transferred to a company which has started commercial production. Other products include a weighted compression jacket for rehabilitation of autistic children which has successfully undergone clinical trials by AIIMS and a Physiogaming glove to be used as a therapeutic aid for kids suffering from cerebral palsy. In 2018, she got the opportunity to mentor a startup company, which is virtually incubated at FITT, and working on design of motion sensing garments for healthcare applications.

Prof Gupta has been fortunate to have been a part of institute administration activities for the past many years. Due to her interest in music she was initially associated with the music club of BRCA as its president for several years. This was followed by a brief stint as Vice President, BRCA. In 2011 she was invited to take up the responsibility of President BRCA, thus becoming the first woman in the history of IITD to do so. During a highly enjoyable tenure of three years, Prof Gupta worked closely with the student teams to bring about major changes in the constitution of BRCA to improve the organizational setup as well as the operations of the club. Prof Gupta was appointed Associate Dean of Infrastructure in 2016 and entrusted with the responsibility of campus development. She is currently involved with the zero waste campus initiative and creation of functional spaces for students & faculty.

Dr Gupta feels fortunate to have been a part of IIT Delhi community for the past 22 years. The opportunities provided to her and the many interactions she has had with colleagues, students and mentors have been great enriching experiences. She is immensely grateful to all who have been a part of this wonderful journey.

Prof D Sundar
Department of Biochemical Engineering and Biotechnology
IIT Delhi

Dr D Sundar is currently a Professor in the Department of Biochemical Engineering and Biotechnology at IIT Delhi. He grew up in Pondicherry and completed his entire schooling from Kendriya Vidyalaya. He went to Pondicherry University and Johns Hopkins University (Baltimore, USA) for his higher education. For his Doctoral work, Prof Sundar developed a novel method for genetic and metabolic pathway engineering of a valuable biopolymer, natural rubber. Prof Sundar then completed a Postdoctoral Fellowship at the Johns Hopkins University in the Department of Chemical & Biomolecular Engineering and the Johns Hopkins Medical Institutions. He was part of the research team that invented the first-generation genome editing tool called zinc finger nucleases and acquired skills in the areas of genome editing, directed evolution, combinatorial protein engineering (modeling, design & selection) and synthetic biology, which are critical for developing the tools and techniques for drug discovery in the post-genomic era. On his return to India, he served as an Assistant Professor in the Centre of Excellence in Bioinformatics at Pondicherry University for three years, before joining the faculty of IIT Delhi in 2008.

While he feels that he has a long way to go, even in satisfying his own standards, Prof Sundar is happy that his research efforts and commitment have been recognized in India and abroad all through the years that he has served as independent faculty at IIT Delhi. As recognition of significant contributions to research, he was awarded the National Bioscience Award in 2013, a highest award instituted by the Department of Biotechnology (DBT), Govt. of India to recognize Indian scientists below the age of 45 years, who have made outstanding contributions in frontier areas of biological sciences. He was also one of the 14 successful Professors from around to world to be recognized with DuPont Young Professor Award in 2013. This global DuPont program, which began in 1968, is designed to identify promising researchers and promising science early in a Professor's career and is administered by the DuPont Center for Collaborative Research and Education, USA. Prof. Sundar was particularly gratified with these awards, since these are given to a select few researchers. Some of the other awards received by Prof. Sundar include - Swarna Jayanti Award (2005, National Academy of Sciences of India, NASI), Young Scientist Award (2006, Indian Science Congress; presented by the then President of India Shri APJ Abdul Kalam), Innovative Young Biotechnologist Award (2006, DBT, Govt. of India), Young Scientist Medal (2008, Indian National Science Academy INSA), Outstanding Young Faculty Fellow (2008, IIT Delhi), Young Researcher Award (2011, Lady Tata Memorial Trust) and Prof. Umakant Sinha Memorial Award (2013, Indian Science Congress). He was among the finalists for the Swarnajayanti Fellowship of DST, Govt. of India and the NASI-SCOPUS Young Scientist Award in 2012 and 2014. He was elected to the Membership of National Academy of Sciences of India in 2011 and was elected to the Fellowship of the Biotech Research Society of India in 2018.

Prof Sundar's main area of research deals with several important aspects of molecular computational biology and bioinformatics. His lab has been critically involved in the study of zinc finger proteins and CRISPR-Cas9 for their various applications in genome engineering. His lab has made significant contribution in understanding zinc finger protein-DNA interactions and in developing novel approaches for understanding its structure and function. This work of Prof Sundar was highlighted by Nature India in 2011. The ability to direct the CRISPR-Cas9 nuclease to a unique target site within a genome would have broad use in targeted genome editing. Prof Sundar's lab has developed genome editing design tools that screens the off-targets using various parameters and predicts the ideal genomic target for guide RNAs in human cell lines. Prof Sundar has been a promoter of open source biology and has made all his developments available for use by the scientific community as freely available resources in the internet.

While Prof Sundar is involved in computational biology research, he also realizes the importance of collaborations with wet-lab scientists. His openness to collaborate with experimentalists is evident from the second area of research that is on the biological activity of natural drugs. He took initiative to set up the first international laboratory at IIT Delhi called DAILAB (DBT-AIST International Laboratory for Advanced Biomedicine) to study the various aspects of understanding the anti-cancer activity of natural drugs. Under this program, his lab has been working in close collaboration with experimentalists from Biomedical Research Institute of the National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan. The collaboration has been very active both in research as well as in organizing educational and training programs at both sides. On the research front, various aspects of understanding the anti-cancer activity of key natural drugs from Indian Ayurvedic herb Ashwagandha has the topic of the collaboration so far. The highlight of this collaboration has been the integration of complementary research expertise available between the two groups. The novel targeted approach to investigate the anti-cancer and neurodegenerative activities of the metabolites from Ashwagandha, is expected to overcome the challenges and roadblocks that prevent us from developing a novel, cheap and natural anticancer drug to serve as an alternative for modern medicine. The above summarized work has led to a number of publications from his lab. DAILAB was inaugurated in IIT Delhi by Dr. R. Chidambaram, the then Principal Scientific Advisor to Govt. of India on November 04, 2015. This initiative aims to translate research conducted here at IIT Delhi out into the broader public health community. DAILAB has become a role model for

international S&T cooperation and as a recognition for its output over the years, DAILAB has been expanded into DAICENTER from 2018, with a large funding from DBT.

In addition to the above two areas, Prof Sundar's lab is also working on diverse biological problems, addressing significant questions using state of the art computational methods. His publications in the areas focusing on Next Generation Sequencing (NGS) BIG DATA analytics have been well recognized. His lab completely understands the significance, impact and scope of computational biology as it is applied to fundamental and outstanding problems in biology studied at the molecular level. He has developed strong collaborations with clinicians at AIIMS to set up a DBT-supported Unit of Excellence (UoE) in Cancer Research in both IIT Delhi and AIIMS.

Prof Sundar leads a well-funded lab. He has received research support form a wide variety of funding sources, having served as a Principal Investigator (PI) on grants from the government funding agencies like the Department of Biotechnology (DBT), Department of Science and Technology (DST), Ministry of Electronics and Information Technology (MeitY) and other sources like DuPont (USA) & Lady Tata Memorial Trust. He is currently the Coordinator and PI of DAICENTER (DBT-AIST International Center for Translational and Environmental Research) and also the Coordinator of the Bioinformatics Centre at IIT Delhi.

Prof Sundar has excellent publication record. He has been a productive researcher and is widely recognized as an accomplished computational biologist whose laboratory focuses on design and analysis of genome editing tools to develop the ability to quantitate and visualize genome editing outcomes and to understand the biological activity of natural drugs.

Prof Sundar has been a dedicated teacher and has mentored many doctoral students. One measure of his successful mentorship is the large number of publications with students as first and/or coauthors and the good positions where the students are placed after their graduation. He believes and understands that his greatest responsibility in teaching is to the graduate students (MS and PhD) for whom he serves as a mentor. He wishes to maximize his efforts in improving their quality and research in the future.

Prof Sundar has actively contributed to administration, both at the Institute level as well as to the department. At the Institute level, he is serving as the Warden of Girnar Hostel since 2013 and was Chairman of Tryst in 2018 and 2019, Convener of Research Committee of the School of Interdisciplinary Research (SIRe) since its inception, served as Convener for both the Faculty Board and the Research Committee of NRCVEE for many years, Curriculum Review & Implementation committees, to name a few, in addition to being part of several important Institute Committees from time to time. At the Department level, he has contributed in several committees like DRC, DUGC, curriculum review, seminar, faculty recruitment, PhD recruitment, etc., in establishment of new laboratories, coordination of national facilities and improvement of procedures/ policies/ practices by working closely with all HoDs/DRC Chairpersons.

Prof Sundar's service outside the Institute includes participation on a number of important national committees and advisory panels. Examples include the Task Force/Technical Expert Committees (TEC) of the Department of Biotechnology (DBT), Govt of India (Theoretical and Computational Biology, Synthetic Biology, HRD programs, JRF Advisory Committee), Atal Incubation Centre scheme of NITI Aayog, several Committees of BCIL and BIRAC, etc. He has also served as the Executive Committee member of Asia Pacific Bioinformatics Network (APBioNET) during 2013-2018.

During his stay at IIT Delhi, Prof Sundar been able to develop a robust research program in the interdisciplinary area of Bioinformatics & Computational Biology and has developed important international collaborations. He has been a Visiting Scientist at Bloomberg School of Public Health at the Johns Hopkins University in Baltimore USA. He is an Adjunct Professor at the Regional Center for Biotechnology (RCB) in Faridabad (An institution of DBT, Govt. of India – under the auspices of UNESCO) and an Invited Guest Researcher at AIST, Tsukuba, Japan. Further details are available at http://web.iitd.ac.in/~sundar/

Some Glimpses of our Lecture Sessions...

Lecture by Dr Ehud Menipaz Chairman, The Ira Foundation of Business, Technology & Society Israel on April 15, 2019 at IIT Delhi

FITT organised lecture on "Industry 4.0 – India Inc Gearing-Up for the Change" for delegates from Samsung STI, South Korea on June 19, 2019 @ IIT Delhi

FITT Footprint

Innovations

Opportunities for IP Licensing

S No	Title	PI/Dept/Centre
1	Three-dimensional integrated weaving of wind blade composite	Prof BK Behera, TT
2	A novel process to develop efficient electrode for efficient vanadium redox flow battery	Prof A Verma, CHEME
3	A formulation for stabilizing bio-therapeutics	Prof AS Rathore, CHEME
4	A method of preparation of reduced graphene oxide nanoparticles	Prof AN Bhaskarwar, CHEME
5	A novel device for measuring pressure pulses based on applanation tonometry	Prof S Roy, AM
6	Optimal reaction load measuring platform	Prof JP Khatait, ME
7	A bioreactor landfill comprising prismoidal lysimeter	Prof S Chakma, CE
8	Method in blockchain systems for fast stabilization and increased responsiveness	Prof VJ Ribeiro, CSE
9	Photobioreactor with novel diffuser design	Prof A Malik, CRDT
10	A system and method of power restoration for supply of uninterrupted power	Prof S Mishra, EE
11	A system for maintenance of root culture for improved viability and propagation	Prof AK Shrivastava, DBEB
12	A grid integrated solar photovoltaic based water pump driven by synchronous reluctance motor	Prof B Singh, EE
13	Artificial skin substitute for burn wounds and trauma care and method of preparation thereof	Prof V Koul, CBME
14	Grid-interactive PV/battery system having switched reluctance motor drive for pumping systems	Prof B Singh, EE
15	Smart Case	Prof S Mukherjee, ME
16	A system for monitoring and control of chromatography	Prof AS Rathore, CHEME
17	An islanded single-stage solar photovoltaic- battery system with grid synchronization capability	Prof B Singh, EE
18	Method to simultaneously enhance signal detector frequency and sensitivity using voltage controlled anisotropy	Prof PK Muduli, PHY
19	Self-lubricating composite bearing and method for preparation thereof	Prof J Bijwe, ITMMEC
20	Method for fabrication of MEMS integrated sensor and sensor thereof	Prof S Dhanekar, CARE
21	Smart bullet proof clothing capable of transmitting signal to a control room	Prof A Majumdar, TT
22	Channelised pneumatic controlled, grouped cushion cum mattress for prevention of bed sores	Prof SN Singh, AM
23	A pateint bed arrangement	Prof SN Singh, AM
24	Tuning shear thickening behaviour by controlling degree of functionalization via synthesis of organically modified silica	Prof L Nebhani, DMSE
25	Brushless DC motor drive with robust position sensorless	Prof B Singh, EE
26	A formulation for stabilizing bio-therapeutics	Prof AS Rathore, CHEME
27	Multi-winding transformer based high resolution power	Prof SK Chattopadhyay, CES
28	A system and method for tapping electric power from a high-voltage direct-current transmission line	Prof A Das, EE
29	Antimicrobial non-woven fabric for safe water filtration	Prof M Joshi, TT
30	Image Sensor	Prof M Suri, EE
31	Field-portable smart phone based auto-fluorescene and fluorescence imaging, spectroscopy and fluorescence micro-endoscopic system: easy to use point-of-care devices for consistent and cost effective-screening of oral, breast, skin and cervical cancer patents	Prof DS Mehta, PHY
32	A novel process of arsenic bioremediation for potable water	Prof GP Agarwal, DBEB
33	A recombinant stationary phase auto-inducible promoter, and implementations thereof	Prof P Srivastava, DBEB
34	Software for diagnosis of cancer	Prof M Suri, EE

35	Software for point of care diagnostics with microscopy	Prof M Suri, EE
36	Apparatus and a method for poling lead free piezoelectric ceramics enhanced piezoelectricity	Prof R Chatterjee, PHY
37	Method for sequestering carbon dioxide by enhancing algal growth, and applications thereof	Prof V Singh, CHEME
38	A self-regenerated catalyst	Prof N Khare, PHY
39	Device for exerting axial load on load bearing joint of human being during scanning	Prof A Singh/ Prof A Mehndiratta, CBME
40	An improved accelerometer	Prof PR Panda, CSE
41	Non-invasive handheld optical sensor for multi-analyte detection in saliva	Prof SK Jha, CBME
42	Horizontal air filtration chamber	Prof SH Kota, CE
43	Indoor air pollution mitigator	Prof SH Kota, CE
44	Vertical air filtration chamber	Prof SH Kota, CE
45	Method in blockchain systems for fast stabilization and increased responsiveness using links	Prof VJ Ribeiro, CSE
46	A single stage solar PV array fed induction motor drive water pumping system	Prof B Singh, EE
47	Composition containing functionalized chitosan, and implementations thereof	Prof V Koul, CBME
48	Actuation platform	Prof JP Khatait, ME
49	Process for producing recombinant peptides	Prof AS Rathore, CHEME
50	Ride-through operation of grid interfaced solar PV system under grid side abnormalities	Prof B Singh, EE
51	A process for preparation of a peptide	Prof S Upadhyayula, CHEME
52	Ionic liquid based support for manufacture of peptides	Prof S Upadhyayula, CHEME

Technologies Transferred @ FITT during Jan- June 2019

S No	Technology Title	Principal Investigator	Centre/ Department
1	A Novel Green micro emulsion for controlling fungal wilt diseases	Prof S Sharma	CRDT
2	Synergy based adaptive transfemoral prosthesis	Prof D Joshi	CBME
3	Odour prevention device	Prof VM Chariar	CRDT
4	Women's Safety Device	Prof A Chawla	ME
5	Development of Biocompatible Surfactant System for Fluoropolymers	Prof B Gupta	TT
6	A process for fractionating components of biomass	Prof N Singh	CBME
7	A device for providing assistance to visually impaired for boarding of public buses	Prof M Balakrishnan	CSE

IIT Delhi's technology on "Preparation of the aliphatic anionic surfactant system" by Prof Bhubnesh Gupta, Dept of Textile Technology transferred to Gujarat Fluorochemicals Ltd on May 9, 2019

IIT Delhi's technology on "Synergy based adaptive transfemoral prosthesis" by Prof Deepak Joshi, CBME, transferred to M/s FUPRO Innovations Pvt Ltd on March 14, 2019

Technology Profiles

Tuning shear thickening behaviour by controlling degree of functionalization via synthesis of organically modified silica

Prof L Nebhani
Department of Materials Science and Engineering
IIT Delhi

Shear-thickening fluids (STFs) is indisputably distinguished from other suspensions due to their remarkable shear-rate-dependent behaviour. Considering critical applied shear rate beyond which the viscosity of a STFs increases rapidly, often by several orders of magnitude. Such a rapid increase in the viscosity has been utilized in variant applications such as upgrading the ballistic impact resistance of soft-body armor and spacecraft shielding concepts for mitigating highly energetic micrometeoroid/orbital debris impact.

Generally STFs consist of a particulate phase dispersed in suspending media. The interaction between the particles and the suspending media can be varied by selecting particles of different shapes, sizes, and surface chemistries to obtain a large variety of application-specific STFs. Shear thickening happens due to jamming and hydrocluster formation between the particles and follows a "hydrocluster mechanism".[1] The STF is a dense colloidal dispersion of nanoparticles and due to Brownian motion, these particles remain in a random position at equilibrium and repulsive forces prevail between them.

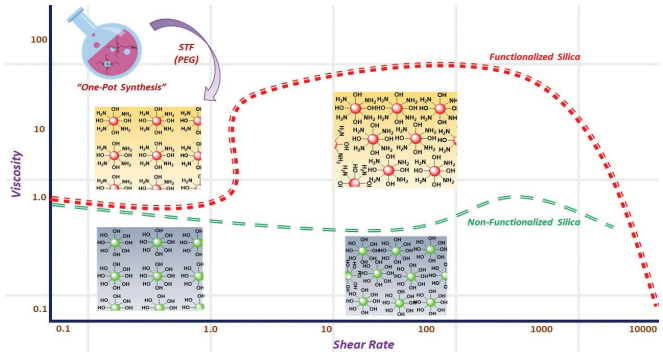
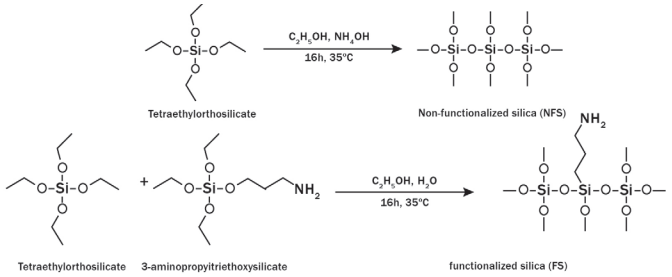


Figure 1: Diagrammatic illustration of change in viscosity for functionalized and non-functionalized silica based STFs at different shear rates.

Predominantly STFs are prepared by dispersing silica particles in a carrier fluid like polyethylene glycol (PEG). For this process usually silica particles are synthesized by the Stöber method in which the precursor tetraethyl orthosilicate (TEOS) undergoes hydrolysis and condensation to form a silica precursor which, upon nucleation and growth, can form silica particles. Moreover, the rheological properties of STFs prepared from these silica particles can be tuned further by changing the particle surface modification and particle–media interactions.[2] Thus an intensive research is required for surface modification of these silica particles, to influence for better understanding of STF and STF carrier interactions. So it is an important parameter to understand the distribution of STFs in any fabric after its impregnation.

The motivation of our work was to evaluate the role of organically modified silica prepared via co-condensation process and to study its shear thickening behaviour compared to non-functionalized silica. Basically there are two main strategies to achieve functionalization of silica. The first approach is post-functionalization and the second approach is co-condensation. The post-functionalization approach has several disadvantages. The first disadvantage associated with post-functionalization is its multistep nature which involves the synthesis of silica followed by functionalization with the desired organoalkoxysilane. In addition, for post-functionalization, not all silanols groups are available and suitable for further functionalization. The post-functionalization method typically results in inhomogeneous surface coverage. The post-functionalization of silica needs to be improved in order to control the amount of incorporated functional groups. Therefore, achieving complete functionalization using post-modification is a challenging task. In contrast, one step co-condensation synthesis with appropriate organoalkoxysilane is a method of choice to reduce cost as well as time for the synthesis of organically modified silica.

Thus we adopted the co-condensation methodology for synthesis of organically functionalized silica from one step approach and evaluate its behaviour as shear thickening fluid. Our strategy involved co-condensation of 3-amiopropyltriethoxysilane (APTES) with TEOS. In this method, APTES is a monomer as well as a catalyst due to the presence of the basic amino group. Further, effect of various loading of APTES (added during preparation of silica) on STF behaviour was also thoroughly studied. After evaluation of rheological properties of STF, impregnation of Kevlar fabric was performed using the prepared STF of non-functionalized as well as functionalized silica.[3]



Scheme 1. General procedure for synthesis of non-functionalized silica (condensation of tetraethyl orthosilicate) and functionalized silica (co-condensation of tetraethyl orthosilicate and 3-aminopropyltriethoxysilane)

Based on viscosity versus shear rate plots, we concluded that it is possible to tune rheological behaviour of functionalized silica by controlling the amount of organic functionalization which is not possible in the case of non-functionalized silica. In addition, functionalized silica showed significant shear thickening at much lower loading (50 wt.%) as compared to non-functionalized silica (in which case extent of shear thickening was very less) as shown in Figure 2.

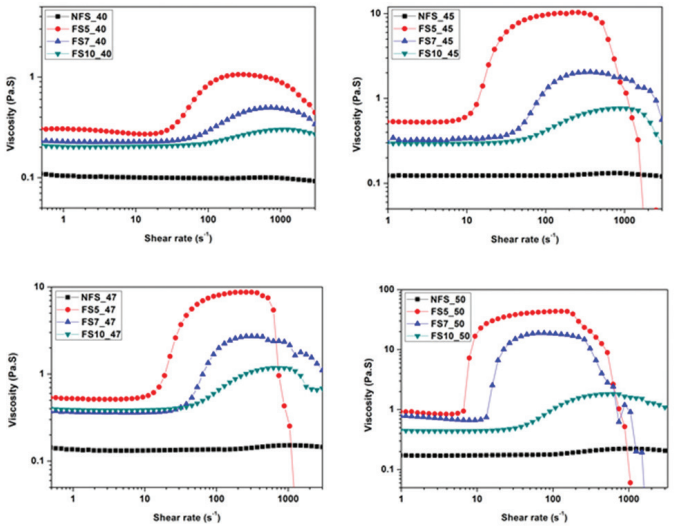
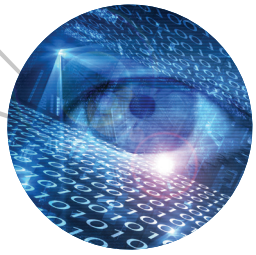


Figure 2: Comparison of viscosity v/s shear rate curves of STF of NFS, FS5, FS7, and FS10 at (a) 40 wt.%, (b) 45 wt.%, (c) 47 wt.%, and (d) 50% silica loading respectively.

The functionalized silica containing lowest concentration of APTES showed significant shear thickening behaviour at lower shear rate as compared to non-functionalized silica due to increased inter-particle interaction through hydrogen bonding. The prepared STFs were further applied on Kevlar fabric in order to study properties of STF impregnated fabric. In this case also, functionalized silica showed higher force required for yarn pull-out (38-39.5 N) as compared to non-functionalized silica where force required for yarn pull-out was 25.8 N. In future, further studies can be carried out to study impact properties of these STF impregnated Kevlar fabrics to explore its application as shock absorbing material.

References:

1. S.R. Raghavan, H.J. Walls, S.A. Khan, Rheology of Silica Dispersions in Organic Liquids: New Evidence for Solvation Forces Dictated by Hydrogen Bonding, Langmuir 2000, 16, 7920–7930.
2. W. Yang, Y. Wu, X. Pei, F. Zhou, Q. Xue, Contribution of surface chemistry to the shear thickening of silica nanoparticle suspensions, Langmuir 2017, 33, 1037–1042.
3. L. Nebhani, S. Sahoo, E. Islam, S. Mishra "Tuning shear thickening behaviour by controlling degree of functionalization via synthesis of organically modified silica", Patent application filed by IIT Delhi (Ref. Number: 201911016109).



Some Examples of Select Investigative/ Development Projects at FITT

S No	Title	PI/Dept/Centre
1	Investigation on the formation of colored product over the surface of copper/brass electrical contracts of starter motor	Prof J Jain, AM
2	Developing criteria including trail runs for suitability of TA Pins	Prof P Mahajan, AM
3	Verification of deflection of flux panel using finite element	Prof P Mahajan, AM
4	Modelling preheating, start-up transience and internal/external cooling processes in hither rating steam turbines	Prof SS Sinha, AM
5	802.11n baseband receiver development	Prof B Lall, EE
6	Algorithmic framework for MEMS sensor fusion applications- Phase-V	Prof A Kumar, CARE
7	Development of algorithms for echo sounder and doppler velocity log for	Prof A Kumar, CARE
8	Development of a software program for day-ahead and intra-day forecasting of solar power generation in the northern Indian region for NRLDC, POSOCO	Prof SB Roy, CAS
9	Photovoltaic systems for African countries (Sierra Leone and Togo)	Prof V Dutta, CES
10	Exploring of PAT based process controls for continuous processing	Prof AS Rathore, CHEME
11	Corning AFR research for transport effects and novel applications: Qualified lab collaboration	Prof S Roy, CHEME
12	Applications of ALD coating for deterrence of abuse potential of APIS	Prof AS Rathore, CHEME
13	Centre for Promotion of Computational Fluid Dynamics	Prof VV Bhuwa, CHEME
14	Water Audit and ETP adequacy of Ashoka Pulp and Paper Pvt Ltd	Prof V Kumar, CRDT
15	To develop meat textured, high protein, plant based products	Prof K Dashora, CRDT

16	Technical evaluation and environment impact assessment of Bio-CNG cum Bio-fertilizer plant establishment at Naurangabad, Haridwar, Uttarakhand	Prof VK Vijay, CRDT
17	Inspection of Grossly Pollution Industries (GPIs) discharging into main stem of river Ganga and its tributaries	Prof V Kumar, CRDT
18	Automated solutions for the metal scrap handling process	Prof V Ramamohan, ME
19	Process development for welded joints	Prof S Aravindan, ME
20	Investigation of edge cracking in high carbon containing stainless steel bars	Prof J Jain, DMSE
21	Controlling intergranular oxidation in steel gears	Prof S Neelakantan, DMSE
22	Opinion on function of spring	Prof J Jain, DMSE
23	Detailed Project Report (DPR) on establishment of Translational/Commercial R&D	Prof AK Ghosh, DMSE
24	Investigation of porosities in membranes	Prof J Jain, DMSE
25	Processing & optimization of polymer toe cap for safety shoes	Prof AK Ghosh, DMSE
26	Impact assessment of Digital villages	Prof J Kumar, Design
27	Impact assessment of DigiGaon	Prof J Kumar, Design
28	Impact assessment of Digitize India Platform	Prof J Kumar, Design
29	Design and development of laser seeker	Prof M Sarkar, EE
30	Joint development of controller for AC asynchronous motor/PMSM motor (3 KW and 12 KW) for electric vehicle, with CDIL	Prof AK Jain, EE
31	DSP based permanent magnet synchronous machine control and validation for gun drives	Prof AK Jain, EE
32	Input point prediction	Prof B Lall, EE
33	Machine Learning models for Quick Service Restaurant (QSR)	Prof Jayadeva, EE
34	Research to use AI/ML geospatial & aerial analytics	Prof AP Prathosh, EE
35	Non contract cardiopulmonary assessment in the wild using imaging techniques	Prof AP Prathosh, EE
36	Fail safety validation of led signal lighting units for railway signalling	Prof A Dixit, EE
37	Development of predictive data analysis system using Artificial Intelligence for DGGI	Prof N Chatterjee, MATHS
38	Development of dual fuel tractor engines using enriched biogas & diesel/bio-diesel	Prof PMV Subbarao, ME
39	Modelling of tensile behavior of Absorptive Glass Mat (AGM) separators	Prof A Rawal, TT
40	Consortium project-GCRF water security and sustainable development hub	Prof CT Dhanya, CE
41	Study of community design for traffic safety in India- Phase-VI	Prof G Tiwari, TRIPP

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
CE : Department of Civil Engineering
CES : Centre for Energy Studies
CHEME : Department of Chemical Engineering
CHY : Department of Chemistry
CRDT : Centre for Rural Development and Technology
CSE : Department of Computer Science and Engineering
DBEB : Department of Biochemical Engineering and Biotechnology
DMS : Department of Management Studies
DMSE : Department of Material Science & Engineering
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
MATHS : Department of Mathematics
ME : Department of Mechanical Engineering
PHY : Department of Physics
TT : Department of Textile Technology
and many more...

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 Member:

1) NABLE IT Consultancy Services 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

IIT Delhi Technologies Available On Water Purification

1) An apparatus and a process for removal of arsenic
2) Recyclable smart mesh for on demand separation of oily water
3) PVA supported resins for arsenic separation and product thereof
4) Antimicrobial non-woven fabric for safe water filtration
5) An apparatus and method for mobile-phone based water purification... and many more

For more details write to: fittlicensingteam@gmail.com

News and Views

Innovation by Indians growing! India marks highest growth in filing for international patents

Good news! India has filed more than two thousand international patent applications, thereby marking the highest growth among the top 15 nations. 'Innovation' is a word that has increasingly evoked more sighs than exclamations across India Inc. Perhaps now this pall of gloom is set to change. Building a robust innovation ecosystem may soon become the norm rather than an unusual occurrence… Source: Financial Express, March 28, 2019

IIT professor, Microsoft scientist bag awards for contributions for linking Computing to Society

The Association for Computing Machinery (ACM) honoured Meenakshi Balakrishnan, an IIT-Delhi professor, who designed a smart cane that allows the visually-impaired to detect items above their knee level, and Victor Bahl, an India-born scientist at Microsoft, for their contributions to shape the role of computing in society.

The 2018 ACM award recipients made seminal contributions to education via textbooks and online education, to the mobile computing community, and technologies to aid the visually-impaired, ACM said. They will be honoured at an ACM function in San Francisco on June 15…. Source: The Business Line, April 24, 2019.

Pollution board, IIT-Delhi ink pact

The Punjab Pollution Control Board (PPCB) has signed a Memorandum of Understanding (MoU) with the Indian Institute of Technology (IIT), Delhi, to check air pollution in the state.

Under the MoU signed on World Environment Day on June 5, the IIT-Delhi will complete the source apportionment (SA) and emission inventory (EI) studies within six months to identify the sources of air pollution in seven cities of Jalandhar, Dera Baba Nanak, Khanna, Dera Bassi, Mandi Gobindgarh, Patiala and Naya Nangal and suggest means to control such emissions... Source: The Tribune - June 7, 2019

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.

Events Jan- June 2019

Dr KR Suresh Nair, Founder & CEO, Design Alpha at FITT, IIT Delhi during the Orientation Program for Technology Enabling Centres of DST on January 29, 2019

IIT Delhi Launched International PhD Fellowship Programme on February 12, 2019 at the Senate Room, II Delhi

FITT Organised IP awareness session on "Copyright Protection & Monetisation" at the IRD Conference Room on March 29, 2019

Delegation from the University of Queens' Belfast visited FITT on May 3, 2019

Center for Automotive Research & Tribology (CART) inaugurated by Prof V Ramgopal Rao, Director, IIT Delhi on May 31, 2019

COE for Promotion of Computational Fluid Dynamics (CFD) was inaugurated by Prof V Ramgopal Rao, Director IIT Delhi and Mr Rafiq Somani, Area Vice President, India and South, ANSYS on May 2, 2019

FITT calls for Proposals under the Biotechnology Ignition Grant (BIG) scheme of BIRAC from July 1 to August 16, 2019.

Details: www.fitt-iitd.org, www.fitt-iitd.in

LEADERSHIP @ FITT

1. Prof V Ramgopal Rao, Director IIT Delhi & Chairman, FITT
2. Dr A Wali, Managing Director
3. Mr KK Roy, Chief Operating Officer

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