

Patent Acquisition and Collaborative Research and Technology Development (PACE)

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Patent Acquisition and Collaborative Research and Technology Development (PACE)

1. PREAMBLE

The Department of Scientific and Industrial Research (DSIR) is continuing to operate the 12th Five Year Plan scheme on “Patent Acquisition and Collaborative Research and Technology Development (PACE)” during 2017-2020. The DSIR through the PACE scheme provides catalytic support to industries and institutions for development and demonstration of innovative product and process technologies, traversing the journey from proof of concept or laboratory stage to pilot stage, so that they can be launched for commercialization. The scheme supports ingenious work and assists in development of new technologies or creative/innovative application of the existing technologies to solve unmet needs of industry. The scheme also strengthens the interface between industry, R&D establishments and academic institutions by supporting collaborative proposals. The scheme also jointly supports initiatives of other Ministries / Departments aimed at technology development and demonstration, e.g. IMPRINT initiative of Ministry of Human Resource Development, wherein institutions of higher learning are being supported for development and demonstration of technologies.

Support is provided for proposals which give clear evidence of existence of proof-of-concept and aim at developing an innovative content for fulfilling an unmet need. Development and demonstration of technologies can be undertaken by industries alone (including in-house R&D centres of the industry recognized by DSIR) or

in collaboration with Universities, Public Funded Research Institutions or academic institutions in India or abroad. The technology development projects supported under the scheme aim at development of a new product or a process with attractive market potential which will result in significant benefits to the industry concerned in terms of raising its technological level, turnover, energy and material savings/recovery, export sales etc. Focus sectors include (i) Energy & Environment, (ii) Affordable healthcare including Drugs & Pharmaceuticals and Medical Equipment & Devices (iii) Agriculture, food & nutrition, (iv) Engineering (auto-components, machine tools & foundry), (v) Specialty Chemicals etc.

2. OBJECTIVES

The objectives of the scheme are:

- i. To support development and demonstration of indigenous product / process technologies, either by industry or by R&D organizations/ academic institutions/ universities aimed at commercialization of new products and processes;
- ii. To jointly support initiatives of other Ministries/ Departments aimed at technology development and demonstration, e.g. IMPRINT initiative of Ministry of Human Resource Development, wherein institutions of higher learning are being supported for development and demonstration of technologies.
- iii. To support collaborative research between Indian Industry and R&D organizations/





academic institutions/ universities for development and demonstration of lab scale technologies, aimed at commercialization of new products and processes;

3. OUTCOME REVIEW OF PACE SCHEME

With the conclusion of 12th Five Year Plan, outcome review of the PACE Schemes was carried out and it has been made coterminous with the Fourteenth Finance Commission (FFC) i.e. till March 2020. The scheme will continue to support industry and/or collaborative proposals for development and demonstration of innovative technologies. Support for technology development projects taken up by higher education institutions in association with Ministry of Human Resource Development (MHRD) under the IMPRINT initiative will also be continued. The component on technology acquisition / technology licensing to industry was recommended to be dropped in view of inadequate response from stakeholders.

Seventh batch of advertisement inviting proposals from industries/institutions for Technology Development and Demonstration projects was issued in Nov. 2017.

4. TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS DURING 2017-18

Details of important projects/activities that were completed or were in progress during the year under report are given below:

4.1 Technology up gradation of pelletization facility for herbal veterinary feed supplements: Demonstration in terms of value addition to produce quality supplements at low cost - Natural Remedies Pvt. Ltd., Bangalore

M/s Natural Remedies Pvt. Ltd., Bangalore have undertaken to demonstrate a steam sterilization based pelletization facility using semi-automated equipment and improved pelletization machine for herbs & herbal powders to produce improved

quality veterinary feed supplements with reduced microbial load and minimal wastage of biomass. The company plans to produce the three existing products viz. Zigbir (hepatoprotective – it helps in optimizing growth, weight gain, feed conservation ratio (FCR) and livability in poultry), Natchol (Choline replacer – it is a natural choline supplement that helps in mobilization of liver fat) and Phytocee (Vitamin C and electrolytes supplier – it is a natural Vitamin C source which helps in reducing free radical formation induced lipid peroxidation) with the new pelletization facility. The project will lead to production of microbe free herbal feed supplements for the benefit of livestock, such as Poultry, aqua ruminants, small ruminants, etc. which will not only protect the animal but also protect human's health who are end consumers of animal products viz. meat, egg and milk.

In the project, a new upgraded pelletization plant has been erected at the project site of M/s Natural Remedies Pvt. Ltd. at Anniyalam, Tamil Nadu and a novel manufacturing process has been established to reduce microbial load in the products adhering to international quality standards and also save electrical energy resulting in cost reduction of manufacturing process, reduction of biomass wastage at different levels of manufacturing process and reduction in dust and noise. Facility is designed to be compliant to FAMI-QS [Feed Additives and Pre-Mixture Quality System] and GMP [Good Manufacturing Practice] standards. This would lead to increase in export revenues. Four Project Review Committee meetings were held to assess the project progress.

The project was sanctioned for support a soft loan of Rs. 200.0 Lakhs out of a total estimated project cost of Rs. 599.30 Lakhs in November 2014. The project has been successfully completed in August 2017 with actual loan support of Rs. 189.70 Lakhs out of total project cost of Rs. 636.64 lakhs.





Side view of Palletization plant at NRPL site



Decontaminator Unit

4.2 Development of Genetically Engineered Cellulose-free Alkaline Xylanase through submerged fermentation process (SMF) - Kaypeeyes Biotech Pvt. Ltd., Mysore

M/s. Kaypeeyes Biotech Pvt. Ltd., Mysore is a company engaged in the manufacture of industrial enzymes like Pectinase, Amylase, Xylanase, Cellulase, Phytase, Amyloglucosidases, Beta-Glucosidases, Acidic & Alkaline proteases and Neutraceuticals, Probiotics for food, feed, therapeutics and other industrial applications. The company had purchased *Bacillus pumilus* culture from RRL, Trivandrum for producing Cellulase free Xylanase at laboratory level. They characterized the kinetics of production of xylanase and developed two products viz. Chlorzyme - AX (Xylanase for bio-bleaching of paper pulp) and Recyclase - X1 (for use in Bio-refinery). These two products were evaluated by CPPRI, Saharanpur and found suitable for paper industry use. The company

however found that yields of the products were inconsistent because of deployment of Solid State fermentation (SSF) method. Also bulk production of products in SSF in wheat bran media had reduced storage stability. Therefore the company took recombinant route of expressing the gene viz. *Bacillus pumilus* in *Pichia pastoris*. *Pichia pastoris* is a well-studied host used in the production of recombinant enzymes world over and being methyl tropic in nature can produce large quantity of enzyme. The company plans to develop, validate and produce recombinant Cellulase - free alkaline Xylanase for application in paper and pulp industries.

The company has successfully transformed *Pichia pastoris* culture which can produce Xylanase in large quantities and has completed trial production in 14 Lts and 70 ltrs fermentor. Transformation and screening of recombinant xylanase produced by *Pichia pastoris* including biochemical studies have been completed. Lab-Scale studies of recombinant xylanase produced by *Pichia pastoris* with aims of maximum cell density production during fermentation have been completed successfully in shake-flask and pilot level. The company has applied for GEAC approval to scale-up at 100 Lts Fermentor at Pilot level at their facility. The dosage and efficiency of recombinant enzyme on paper recycling were studied at different paper mills at Mysore and Erode.

The project was sanctioned for support a soft loan of Rs. 206.00 Lakhs out of a total project cost of Rs. 468.00 Lakhs in November, 2014. The project has been successfully completed with actual loan support of Rs. 165.0 Lakhs.

4.3 Design, Manufacturing, Proving, Supply of Three Roller Flow Forming Machine - Paras Flowform Engineering Ltd., Mumbai

M/s. Paras Flowform Engineering Ltd., Mumbai are mainly in the business of manufacturing of Flow-forming chambers for missiles & rockets; CNC Machining for aerospace & defense industries; turn key projects for non-ferrous mining & metallurgical industries, heavy





machining & fabrication of the same; special purpose machines; rolling mill equipment & turnkey electronic systems for communication, radar, sonar, fire control, etc for Indian Army & Navy. They have taken up design and manufacture of a new 3 Roller CNC Flow-forming machines with advance controls after successful in-house refurbishment of 3 roller Flow-forming machine (procured as scrap) from overseas in the year 2010. The refurbished machine is presently producing Pinaka Motor Tubes etc. The company utilized the expertise of IIT, Mumbai and ARDE, Pune for up-scaling in the areas like Design, Electronics before commercialization. The innovation lies in carrying out the mechanical fabrication maintaining the roundness, concentricity & straightness of the tubes with high precision. The prototype machine has been fabricated.

The project was sanctioned for support a soft loan of Rs. 500.00 Lakhs out of a total project cost of Rs. 1900.00 Lakhs in November, 2014. The project has been completed with actual loan support of Rs. 400.0 Lakhs.

4.4 Macroalgal Biorefinery for CO₂ Sequestration and Production of Biofuel and Value-Added Compounds - AquAgri Processing Pvt. Ltd., New Delhi & DBT-ICT Centre for Energy Biosciences & CSIR- CSMSRI, Bhavnagar

M/s AquAgri Processing Pvt. Ltd., New Delhi in collaboration with DBT-ICT Centre for Energy Biosciences, Institute of Chemical Technology (ICT), Mumbai and CSIR- Central Salt & Marine Chemicals Research Institute, Bhavnagar (CSIR-CSMCRI) have undertaken to demonstrate the concept of sequestration of CO₂ through large scale controlled growth of macroalgal species (Ulva) in closed photo-bioreactors using CO₂ generated by power plants or other industries, and making the technology sustainable through conversion of the grown macroalgal biomass to bioenergy and other value-added products. Globally the dry sea plants are used to manufacture hydrocolloids and these have a wide application in food, cosmetics and toiletry industry. Aqua Sap derived from

the fresh living algal plants is a plant nutrient, which contains substantial amounts of micro and macronutrients, naturally occurring Plant Growth Regulators (PGRs) and amino acids. The PGRs such as Auxins, Cytokinins and Gibberellins, accelerate the metabolic function of the plant there by boosting yield and productivity. The concept of a multi-product macroalgal refinery using modular photo-bioreactors for CO₂ capture and growth of ulva in vertical glass reactors to demonstrate efficient CO₂ sequestration coupled with downstream processing technologies for biomass deconstruction and separation of value-added products for economic sustainability is an innovative concept.

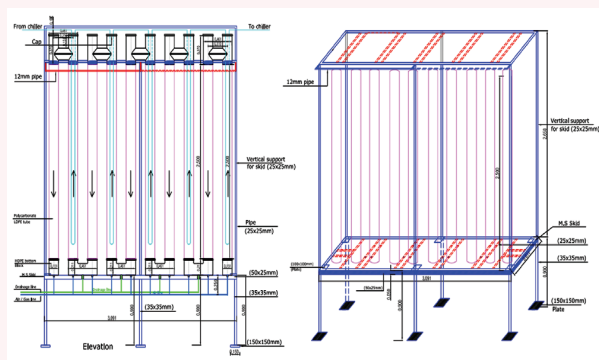
In phase-I, ICT and CSIR-CSMCRI has demonstrated ulva cultivation in flat panel and tubular photo-bioreactors (PBRs) at ICT with various designs. Although flat panel bioreactors gave a Daily Growth Rate (DGR) upwards of 30% but to reduce the capital cost as well as the operating energy cost, tubular PBRs were designed using both, flexible HDPE and polycarbonate. The design of the bio-reactor has now reached the final form and is being run continuously to validate the entire operating data. In phase-II, a 100 KL scaled up plant would be erected at Aquagri for demonstration. A tractable integrated process facilitating sequential extraction of the major value added components such as sap, lipids, protein ulvan and cellulose has also been achieved and a 10KL extraction unit for downstream processing of ulva biomass is already commissioned at M/s Aquagri project site.

This project has been supported by DSIR through a soft loan of Rs. 225.00 Lakhs to M/s AquAgri Processing Pvt. Ltd., New Delhi and grants of Rs. 85.00 Lakhs to ICT and Rs. 45.00 Lakhs to CSIR-CSMCRI out of a total project cost of Rs. 580.00 Lakhs in November 2014. The project is in two phases and is under progress and so far five Project Review Committee meetings have been held to review the progress of project.





Air-lift Tubular PBRs with low power efficient sparging system



View of the tubular PBRs and the skid design

4.5 Chitosan Based Drug Delivery system for Dental and Oral Diseases - ICPA Health Products Ltd., Ankleshwar & Govt. College of Pharmacy, Aurangabad

M/s. ICPA Health Products Ltd., Ankleshwar, leader in Oral Health Care and has proposed to scale-up production of chitosan films from lab scale (400 units/ batch/day) to pilot scale (20,000 units/ batch/day). They intend to complete successfully pilot batches and target at 200,000 patches/ batch/day to cater to the market demand. The company has signed MOU with Govt. College of Pharmacy, Aurangabad on

various chitosan based technologies. Govt. College of Pharmacy, Aurangabad has developed chitosan based thin film at lab-scale wherein film patches are casted manually. They have been producing 75 pieces of chitosan films in 4 hours costing at Rs. 6.50 lakhs a piece manually. The Govt. College of Pharmacy, Aurangabad have synthesized 3 derivatives Caboxylated Methyl Chitosan, Chitosan Lactate & Chitosan Ascorbate. The Collaborator have prepared/ manufactured 200 chitosan patches or films/ day using the High-Speed Mixing machine (VMC-2 model) manually in their lab and are now planning to produce the same by automating the same machine in the lab. The company has procured, installed & commissioned pilot plant equipment and also chitosan & raw materials. Also first Machine prototype developed and fabrication of the same in progress. Standardization of Acetate, Lactate & Caboxylated Methyl Chitosan derivatives for their use completed. The formulation development has been initiated.

The project has been supported by DSIR with a soft loan of Rs. 72.00 Lakhs to M/s. ICPA Health Products Ltd and a grant of Rs. 72.00 lakh to Govt. College of Pharmacy, Aurangabad out of a total project cost of Rs. 260.00 Lakhs in December, 2014. The Project is under progress.

4.6 Development of Controller Release [CR] Formulation of Natural Highly-Purified Human Chorionic Gonadotropin [hCG] – M/s Sanzyme Ltd. Hyderabad & ICT Mumbai

Sanzyme Ltd., Hyderabad in collaboration with Department of Pharmaceutical Sciences & Tech., Institute of Chemical Technology, Mumbai had submitted a project proposal on “Development of Controlled Release [CR] Formulation of Natural Highly - Purified Human Chorionic Gonadotropin [hCG] for possible support under PACE-TDD scheme. 99% pure hCG is used as a surrogate for LH [Lutenising Hormone] for triggering ovulation and maintenance of pregnancy. However recent developments, have shown that the role of hCG is not restricted to infertility treatment alone but has wider applications in the field of metabolic





disorders such as Diabetes and other clinical conditions where hCG is being used for a process known as angiogenesis in the fields of vascular surgery and CNS surgery. Currently two forms or variants of hCG are available either as highly purified form or the recombinant version of hCG. Despite recombinant being available, only a single dosage form is available for clinical use. The project aims to improve compliance and reduce the frequency of injections and make the treatment more affordable and available to masses rather than class alone. The CR- release formulation using nano technology with release rates of either 15 or 30 days will reduce the frequency of injections required in infertility problems, maintenance of pregnancy and controlling metabolic disorders such as Diabetes.

The project has been supported by DSIR with a soft loan of Rs. 52.50 Lakhs to M/s. Sanzyme Ltd. Hyderabad and a grant of Rs. 52.24 lakhs to ICT, Mumbai out of a total project cost of Rs. 159.55 Lakhs in December, 2016. The Project is under progress.

4.7 Cold plasma based technology development for green ammonia/urea production – M/s Nagarjuna Fertilizers and Chemicals Limited, Hyderabad.

Nagarjuna Fertilizers and Chemicals Limited, Hyderabad had submitted a project proposal “Cold Plasma based Technology Development for Green Ammonia / Urea Production” for possible support under PACE-TDD scheme. The project aims at developing a technology platform for production of Green Ammonia / Urea by non-conventional production route using cold plasma based technology and process simulation & engineering design and upscaling the process to multi ton stage. The project shall develop a non-conventional source for ammonia/urea production where the requirement of pressure is not limiting. The process once optimized can be operated in integrated manner with existing urea/ammonia industries and it will also be possible to decentralize production. Therefore, to validate the technology it is essential to study the developed

technology at higher scale. Additionally, strategies for production of ammonia/urea will also be studied in packed bed reactor which may be cold plasma based or packed bed reactor connected to cold plasma with metal oxide catalyst to maximize the production capabilities.

The project has been supported by DSIR with a soft loan of Rs. 500.00 Lakhs to M/s Nagarjuna Fertilizers and Chemicals Limited, Hyderabad out of a total project cost of Rs. 1125.50 Lakhs in December, 2016. The Project is under progress.

4.8 Cost-effective 3G/4G based Multimedia Video Conferencing Service – Intellisys Technologies & Research Ltd., Kolkata

M/s Intellisys Technologies & Research Ltd., Kolkata is a high end global R&D company in the area of videoconferencing technology and communication space. One of its previous products “Enlitor”- a learning management system developed in joint collaboration with NSE.IT Ltd., (a 100% subsidiary of National Stock Exchange of India) was implemented across the country. The company has developed a product “Vennefer”- unique H.264 high definition software based multiparty multipoint video conferencing solutions on multicast network transmission protocol. The company plans to build a suite of products & services on the “Vennefer Mobility Cloud” which will produce unified collaboration across a range of standard audio visual rooms, business desktop solutions, smart-phones & tablets. The proposal envisages offering video telephony (point-to-point) and conferencing (multipoint-to-multipoint) as a service, for building this application, the company will need technologies for SoftMCU, WebRTC to SIP gateway & SIP to H.323 interoperability module, which they plan to acquire from Synergy Research, USA and Doubango Telecom, France or could even develop them in-house. The company will be scaling up relay & media server bandwidth up to 32 kbps using cluster methodologies for 4 lakhs subscribers and host the application with M/s. TATAs as the ISP/TELCO. During the commercialization phase, the company will host the application to data centers of ISPs or



TELCOs and would generate revenue on pay per use basis. The company expects to have around 50 lakh licenses in 5 years of commercialization and expects revenue of Rs. 10 crore / month @ Rs. 20 per user per month.

The project has been supported by DSIR with a soft loan of Rs. 251.50 Lakhs to out of a total project cost of Rs. 703.0 Lakhs in January, 2017. The Project is under progress.

5. TECHNOLOGY DEVELOPMENT PROJECTS UNDER IMPRINT INITIATIVE

IMPacting Research INnovation and Technology (IMPRINT), the first-of-its-kind Pan-IIT and IISc joint initiative, is a Ministry of Human Resource Development (MHRD) initiative to address major engineering challenges that the country must address and champion to enable, empower and embolden the nation for inclusive growth and self-reliance. Department of Scientific and Industrial Research is partnering with MHRD in implementing this program. In order to pursue the mandates of IMPRINT, ten technology domains as grand engineering challenges have been thought of. DSIR is contributing in two sectors, viz, Manufacturing Technology and Water Resources. Five IMPRINT proposals of IITs/IISc/NITs in the two identified sectors for DSIR (Manufacturing Technologies and Water Resources) have been supported. DSIR support will be of Rs. 257.665 lakh over 2016-17, 2017-18 and 2018-19 and a matching amount shall be supported by MHRD. The supported projects are as follows:

5.1 Development of an innovative process to fabricate ultra-fine grained bimetallic thin sheets for microforming applications - IIT Madras and IISc Bangalore

The project aims to develop micro deep drawn components made up of bimetallics with ultrafine grained microstructure. Such micro-components have potential application in many industries such as consumer electronics, telecommunication, micro electro-mechanical system (MEMS), aerospace and defence. For this purpose, a novel approach

involving combination of cryorolling (CR), warm roll bonding (RB) and asymmetric rolling (AR) have been proposed, aimed to fabricate thin bimetallic sheet, with equiaxed ultra-fine grained (UFG) microstructure. Possible advantages of using such material in microforming are: (i) Improved microformability by engineering desirable texture (ii) Overcoming challenges associated with size effect as observed during micro-manufacturing (iii) Strong interfacial bonding at bimetallic interface (iv) Excellent mechanical strength due to presence of UFG microstructure. There are two major novel ideas involved in this proposal:

(i) Although all the three rolling processes (CR, RB, AR) has been extensively studied in a standalone basis, its only recently, researchers are trying to combine various process to tailor required properties in sheet metals. In the present work, a novel combination of CR+ warm RB + AR is proposed for the first time to develop UFG bimetallic thin sheets. The thin UFG bimetallic sheets developed by this innovative method are expected to provide favourable texture for microforming, high bond strength between bimetallic interface and improved microformability.

(ii) Microforming itself is a less explored domain. Although some progress has been made to microform metals and alloy, no attempt has been made by any researchers to obtain bimetallic micro-components of ultrafine grained microstructure using microforming process.

Bhabha Atomic Research Centre is a potential end user of the bimetallic micro components made by the proposed method. The Centre for Design and Manufacture, BARC has highlighted that product developed by this technology will find many purposeful applications in the Centre.

5.2 Fabrication and evaluation of atomic force microscope probes with detachable and re-usable tips - Indian Institute of Science, Bangalore in partnership with i2n Technologies Private Limited, Bangalore

The broad applications of atomic force microscope (AFM), from in-line nanometrology and imaging





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to nano-manipulation, are ultimately tied to the AFM probe. The AFM probe is a consumable part requiring frequent replacement, and its high cost contributes significantly to the running costs of AFM. The probe needs replacement when its tip is damaged even if the rest of it is functional. Here we propose batch fabrication of AFM probes wherein the probe-tip alone is replaced. Since several thousand tips can be fabricated in the same area as a conventional probe, this approach is highly cost-effective and facilitates development of advanced probing systems. The main objectives of the project are i) tip-less AFM cantilevers and detachable AFM tips are fabricated; ii) an AFM cantilever carrying a detachable tip is evaluated by imaging nanomaterials in different modalities and iii) automated detection of tip-wear, tip-replacement and re-use would be demonstrated.

To ensure quality control during nano-fabrication, it is essential to employ in-situ inline inspection and metrology tools. The AFM is the primary tool suited for this requirement since, unlike competing techniques such as the SEM and TEM, the AFM can operate in-situ with sub-nanometer precision and interact with a range of samples. However, every AFM requires frequent replacement of its tip, and the existing replacement techniques suffer from limitations ranging from imprecision, excessive time consumption to high cost that together act as major impediments for industrial use of AFM. The proposed replaceable tips address these issues and possess the following advantages:

1. The cost of replacement a single tip is reduced significantly. The probe is not replaced, and hence its properties need not be recalibrated.
2. Automated in-line inspection with reduced replacement time and increased precision can be achieved
3. Enables employing more sophisticated probes, with integrated sensing and actuation to achieve controlled interaction with 3D nano-scale samples.

5.3 Low-cost Additive Manufacturing Technique for Fabricating Through-Substrate Vias based Three-dimensional Microstructures used in MEMS Applications – IIT Bombay

A low-cost additive manufacturing technique is proposed to fabricate 3D microstructures required in MEMS applications, such as inductors. In the proposed 3D microstructures, top structures will be connected to the bottom structures by vertical metal-filled vias known as through-substrate vias (TSV). A low-cost electrochemical-discharge machining (ECDM) will be used to create holes in borosilicate-glass and silicon substrates. Conductive metals such as copper, nickel, etc., will be deposited in these holes by a novel void-free „aspect-ratio-dependent electrodeposition“ technique. To form top-side and bottom-side coils, layer-by-layer polymer lamination and electrodeposition will be used. Wettability study of polymer mold with the electrolyte will be performed. Electrical characterization and reliability analysis of metal-filled TSV will be carried out. The TSV-based 3D inductors made by the proposed method will incur lower fabrication cost, shorter electrical interconnect path, faster signal speed and reduced foot-print area as compared to conventional inductors.

5.4 Designing and fabrication of an aerodynamic lens for nanoparticles of variable size – IIT Hyderabad

The main objective of the project is to design and fabricate an instrument (aerodynamic lens) to tightly collimate beams of nano/microparticles and fabricate a high resolution mass and imaging spectrometer for real-time analysis of the chemical composition of aerosols with designed mass resolutions of $m/\Delta m$ of ~ 700 , upto a mass of 800 amu., with fast response rates upto 10 Hz or better. The project also aims to develop a large through put method to fabricate microstructures with resolutions of better than 0.5 μm using the aerodynamic lens system. The robust and compact instrument will be designed for deployment on



mobile systems, terrestrial and airborne. The industry partner for the project is H Fillunger and Co Pvt Ltd, having extensive experience in vacuum systems, plasma deposition systems etc will collaborate in the fabrication of the lens system. The project also proposes to develop a methodology for deposition of thin and uniform layers on surfaces for additive fabrication of microstructures using the lens system.

5.5 Continuous discharge measurement in small open channels by using ultrasonic tomography – IIT Kanpur

The project aims to develop a continuous real-time discharge monitoring system for small open channels (width 1 to 50 m) by tomographic reconstruction of ultrasonic transit-time measurements. The system will be designed to be accurate, cost-effective, field deployable, easy to calibrate and capable of unattended real-time data transmission. The developed system will be tested under laboratory and field conditions and determine its range of measurement errors under different channel geometry and flow conditions.

The developed system will be developed into a user-friendly commercial product.

Small rivers and channels dominate Indian rural and urban landscape. Monitoring discharge in them has direct utility in managing water-resource distribution issues prevalent in India today. The infrastructure for discharge data collection in small rivers is either absent or greatly limited by manual methods that use current-meters, floats, and gauges. The continuous discharge monitoring instruments that are readily available in the market like Acoustic Doppler Current Profiler (ADCP) and Laser Doppler Anemometer (LDA) are too expensive for multiple deployments. The motivation is to fill this gap by developing a discharge measurement system that is inexpensive, easy to deploy, operate and maintain, and requires minimum calibration. The scope of this project is to develop and test an ultrasonic transit-time discharge measurement system for small channels (width 1 to 50 m). The configuration of the ultrasonic transducers will be designed to get a cost effective flowmeter with measurement error of less than 5%.



