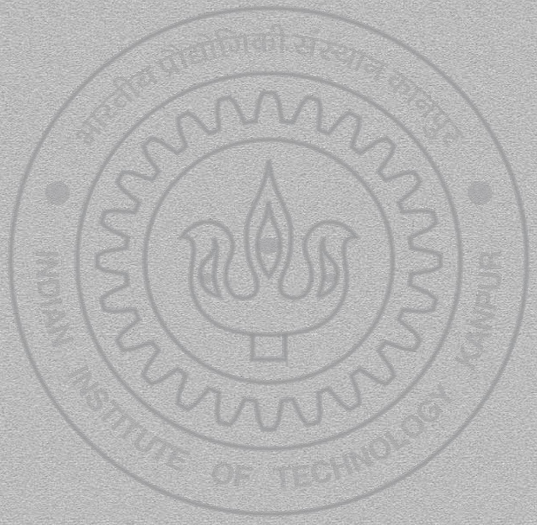

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TECHNOLOGY DEVELOPMENT AT IIT KANPUR

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MEDICAL DEVICE TECHNOLOGY

MEDICAL DEVICE TECHNOLOGY

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> "Cervical cancer can often be found early and sometimes even prevented entirely, by having regular Pap tests. If detected early, cervical cancer is one of the most successfully treatable cancers"
>
> – American Cancer Society

MARKET / RELATED PRODUCTS / BENEFITS

Worldwide, cervical cancer is among the most common cancers in women and it is the third leading cause of death today. In India, cervical cancer is ranked as the most frequent cancer in women with a population of approximately 365.71 million women above 15 years of age, who are at risk of developing cervical cancer. The current estimates indicate approximately 132,000 new cases diagnosed and 74,000 deaths annually in India, accounting to nearly 1/3rd of the global cervical cancer deaths. At any given time, about 6.6% of women in the general population are estimated to harbor cervical HPV infection. HPV serotypes 16 and 18 account for nearly 76.7% of cervical cancer in India. Access to medical professionals for testing is not available, too expensive or challenging for the average rural family. Early stage detection can minimize mortality due to cervical cancer and is imperative for complete cure. Present methods for detection of cervical cancer are Pap smear (Papanicolaou test) and colposcopy followed by biopsy and the histopathology examination for final diagnosis and grading. Pap smear has high specificity (>95%) but low sensitivity (<50%) and colposcopy has high sensitivity (>90%) but low specificity (<50%). This indicates that many samples are overcalled or missed in conventional methods. Additionally, such tests are expensive and require experienced professionals. To overcome this, we need a technique which is more accurate, fast and minimally invasive. Optical detection methods like fluorescence spectroscopy, elastic scattering and imaging have the potential for early diagnosis and are able to monitor cellular and chemical changes with disease progression. Fluorescence spectroscopy is one of the relatively sensitive methods to probe subtle biochemical changes. Several researchers have used this technique to detect cervical cancer. However the fluorescence from tissue is significantly modulated by absorption and scattering effects at both the excitation and emission wavelengths, so information of biochemical changes with disease progression are often masked. This could affect the results further in in-vivo measurements, where blood and other body fluids are present. It is thus necessary to remove such effects. We have developed an experimental technique to extract the intrinsic fluorescence from

biological tissue samples. The intrinsic fluorescence is free from these distortion effects, hence this provides more precise information about biochemical changes as compared to the un-polarized, co-polarized and cross-polarized spectra. Exploiting this technique a rudimentary portable fluorescence probe has been developed and tested over 166 sites of 60 samples. According to histopathology report these sites contains 25 normal, 112 CINI (cervical intraepithelial neoplasia I) and 29 CINII sites, which shows promise as an in-vivo detection system of cervical precancer.

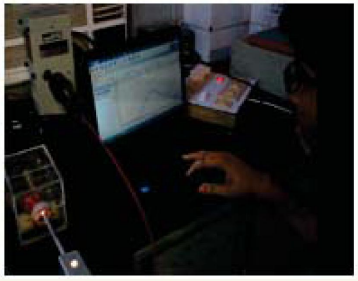
NEW TECHNOLOGY

We have partnered with GSVM Medical College, Kanpur to develop a technique which is more accurate, fast and minimally invasive. Using optical detection methods like fluorescence spectroscopy and elastic scattering, our approach is able to monitor cellular and chemical changes with disease progression and facilitate early detection of cancerous activity. A portable device implements our unique approach incorporating a diode laser, a white light source (Xe-lamp), beam splitters, polarizers, spectrometer, and a long pass filter coupled with sophisticated software to extract intrinsic fluorescence, potential cancerous activity and to classify cervical tissue grades. The rudimentary device which is placed in the GSVM medical college is shown in the figure below. Currently testing is being performed on fresh uterus samples. Ultimately a cost effective device implementing this technology can be used in the field by minimally trained social workers to screen patients in clinics, display immediate results and take prompt actions for further medical care as needed to save lives.

FACILITIES

In our laboratory following facilities are available:

- Fluorescence lifetime imaging microscopy (FLIM) system
- Mueller matrix imaging (in house developed)system
- Spectrofluorometer
- Fluorescence diffuse optical tomography (FDOT)
- Oral cancer detection device (In house Developed)



FACULTY / AREAS OF EXPERTISE

Dr. Asima Pradhan

Research Interests: Biomedical optics

Dr. Saurabh Mani Tripathi

Research Interests: Fiber-optic biological and chemical sensors, optical waveguide gratings, modal-interference effect based guided wave devices, integrated optical devices, surface Plasmon polariton and metamaterial based IR and terahertz sensors.

Dr. Naren Naik

Research Interests: Development and analysis of reconstruction approaches for nonlinear tomography, Numerical solutions of propagation and scattering problems, subsurface imaging, biomedical imaging

Dr. Bushra Ateeq

Research Interests: The primary research focus of Dr. Bushra's laboratory is to understand the complex molecular events involved in prostate and breast cancer, identify early diagnostic markers and valuable therapeutic targets.

Contact

Dr. Asima Pradhan
Department of Physics & CELP, IIT Kanpur, Kanpur, Uttar Pradesh 208016, India
Tel.: 91-512-2597691 | Phone: (+91) 9956783205 | Email: asima@iitk.ac.in

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HIGH EFFICIENCY VERTICAL AXIS WIND TURBINE

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MARKET / RELATED PRODUCTS / BENEFITS

Clean, renewable energy sources are key to addressing climate change, emissions, costs and risks associated with the use of fossil fuels. Wind power is a promising alternative amongst a list of renewable power sources such as solar. Traditional solutions consist of axial wind turbines, large fans, that are mounted in high wind areas (hilltops, near-shore in the sea) at high cost. Most of the commercial-scale turbines installed today are 2 MW in size and cost roughly $3-$4 million installed. Wind turbines have significant economies of scale. Smaller farm or residential scale turbines cost less overall, but are more expensive per kilowatt of energy producing capacity. Wind turbines under 100 kilowatts cost roughly $3,000 to $8,000 per kilowatt of capacity. A 10 kilowatt machine (the size needed to power a large home) might have an installed cost of $50,000 - $80,000 (or more) depending on the tower type, height, and the cost of installation. Productive wind speeds will range between 4 m/sec to 35 m/sec. Challenges to wind power are remote locations of wind farms, consequent grid transmission losses, dwindling access to productive sites. This increases pressure for turbine technology that can more efficiently generate power at lower wind speeds and at locations closer to points of consumption. The solution to some of these challenges lies in “small wind energy and hybrid systems”. The potential market for renewable energy based micro generation as per a study conducted by World Institute of Sustainable Energy (WISE) (in 2009) is estimated at 83,000+ MW.

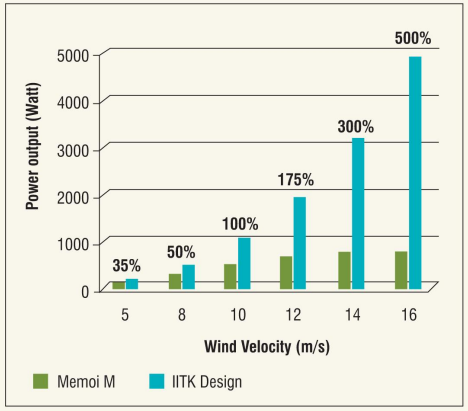

Figure 1: Expected power output comparison and percent improvement as compared to existing design

NEW TECHNOLOGY

High efficiency vertical axis wind turbines that are ideal for urban locations (due to low noise), closer to points of power consumption, at lower wind speeds and promise to have 2X to 4X power generation capacity of current vertical axis turbine products (see comparison above). Suitable for hybrid (wind + solar) setups. Due to lower rotational speeds, offers lesser maintenance and greater durability.

Contact

Dr. Abhishek
Tel: +91-8765069138, +91-5122597515 | Email: abhish@iitk.ac.in

> “Wind power is currently the fastest-growing source of electricity production in the world.”
>
> – Wind Energy Foundation

FACILITIES

High Speed Aerodynamics Laboratory houses an intermittent, blowdown type trisonic wind tunnel equipped with a dedicated system for flow control and data acquisition. It also has facilities for studying high speed jets and aeroacoustics.

Low Speed Aerodynamics Laboratory is equipped with various wind tunnels including a low turbulence tunnel, boundary layer tunnel, 5-D tunnel with twin test-sections, smoke tunnel (all with state of the art instrumentation for flow visualization and analysis) to carry out experimental research in unsteady aerodynamics, flow control, bluff body flows, wind engineering and transition of flows.

Unsteady Aerodynamics Laboratory focuses on research in flapping wing UAV, transition of unsteady wall bounded and buoyant free shear flows, incompressible and compressible vortex rings and its interaction noise using PIV, PLIF, BOS, Flow Visualization, microphone and unsteady pressure measurements.

Structures Laboratory has material characterization facilities for both quasi-static and dynamic conditions. It houses a dynamic mechanical analyzer, drop tower, TMA, DSC, PGA, UTM, photo-elasticity and interferometry, fabrication and testing of smart materials and composite structures.

Combustion Laboratory is equipped with instruments for spray measurement, visualization of cold and reacting flows, PIV and chemiluminescence to carry out applied research in combustion of liquid and gaseous fuels.

Propulsion Laboratory is equipped with a linear cascade tunnel, which is used to study compressor and turbine aerodynamics and air intakes. It also houses a gas turbine engine, continuous combustion unit and a two-stage axial fan for undergraduate experiments. Turbomachinery and flow control research is carried out in the laboratory.

Flame and Combustion Dynamics Laboratory is a national facility established in collaboration with Department of Atomic Energy, India, to study fire propagation and thermo-hydraulic aspects of fire in multiple compartments as well as fundamental research in combustion dynamics and stability. It has state of the art instrumentation such as PIV, LIF, LDV, LII and POPA. It also houses a computational laboratory for combustion and fire simulation.

Flight Laboratory is a unique facility in the entire country equipped with appropriately instrumented aircrafts to conduct experiments and research in the areas of parameter estimation, high angle of attack aerodynamics, atmospheric characterization and measurements pertaining to environment. It houses three single engine airplanes: Cessna Stationaair, Piper Saratoga-II and a Hansa-111 - a fully instrumented aircraft, and several gliders. The flight laboratory also runs courses in flight testing wherein students from various engineering institutes participate to collect, analyze and evaluate performance and handling parameters of the airplanes, and operates a gliding center.

Virtual Instrumentation Laboratory provides a hands-on experience to create user-defined measurement systems using customizable software, modular instrumentation hardwares such as plug-in boards and driver software.

Helicopter Laboratory is involved in the design and development of autonomous unmanned mini/micro helicopters and wind turbines. The lab is involved in solving barrier problems associated with helicopter dynamics, aerodynamics and flight mechanics.

National Wind Tunnel Facility - Designed and developed by the Aerospace Engineering Department, IIT Kanpur, this national facility was established in 1999 to meet the national needs in areas of aeronautical and non-aeronautical R&D activities. It houses one of the most versatile and efficient wind tunnels in India. The tunnel is a state-of-the-art 3m x 2.25m closed circuit low speed wind tunnel capable of testing at a wind speed up to 90 m/sec and turbulence level less than 0.05%.

FACULTY / AREAS OF EXPERTISE

Dr. Abhishek
PhD (University of Maryland, College Park) - Rotary Wing Aeromechanics, Autonomous MAV/UAVs, Wind Turbines.

Dr. Abhijit Kushari
PhD (Georgia Tech) - Liquid Atomization, Combustion, Flow Control, Turbomachinery, Electric Propulsion.

Dr. C. S. Upadhyay
PhD (Texas A&M) - Solid Mechanics, Adaptive Finite Element Methods, Structural Optimization and Design.

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ADVANCED HIGH ENDURANCE QUADCOPTER TECHNOLOGY

ADVANCED HIGH ENDURANCE QUADCOPTER TECHNOLOGY

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> "The future will be autonomous and airborne"
>
> – Business Standard

MARKET / RELATED PRODUCTS / BENEFITS

Among the various UAVs developed in recent times, Quadcopter is commercially the most successful model for civilian use in low to moderate payload market. The commercial success for this configuration can be gauged from the fact that, electric powered quadrotors with all up weights ranging from 50 grams to 15-20 kg can be bought off-the-shelf and can be used for a variety of missions – package delivery (shipping/logistics), surveillance, mapping, photography. Market Global Forecast, 2014 – 2019 that projects the small UAV market will grow to $582.2 million over a six year time period. This represents a global compound annual growth rate (CAGR) of 21.7 percent.

However, these missions are limited due to small payload constraint (less than10 kgs) and short flight times or endurance (15 to 25 minutes). These shortcomings restrict these quadrotors from getting used for more serious industrial applications where payload requirements may be greater than 10-20 kgs. It should be noted that these shortcomings cannot be addressed by simply making larger quadrotors of same type. To understand this we need to identify that the flight control and navigation of electric motor powered quadrotors is done by varying the rotational speed (RPM) of motors, which regulates the thrust / lift generated by each propeller. This is not possible as the size becomes large, due to increased motor inertia.

NEW TECHNOLOGY

The proposed design of variable pitch quadrotor aims at addressing these limitations by adopting a new method for controlling the quadrotor. Two key changes are proposed:

- Use of variable pitch for changing the thrust over each rotor instead of RPM change.
- Use of one IC (Internal Combustion) engine to power all the rotors and gasoline (has high energy density) instead of batteries for powering the vehicle.

Due to these enhancements the quadrotor vehicle application can be extended to wide range of sizes meeting larger payload and endurance requirements making them strong candidate for serious industrial usage.

This technology is being created to address the shortcomings of the existing breed of battery powered quadrotors which suffer from following deficiencies:

- With the current state of energy density of batteries available, endurance of electric quadrotors is limited to 15-25 minutes for vehicles designed to lift optimal payload, which limits the flight range, thereby limiting the suitability of the design for various missions.
- As the size increases, the quadrotor can no longer be stabilized through RPM control alone, as a point can be reached where the torque required to change the rotational velocity of the motor quickly exceeds the capacity of the motor. This limits the size of the quadrotors and therefore puts a constraint on the maximum payload that can be lifted with such vehicles. Further, changing the speed of large propellers or rotors can create problem of resonance, as the rotating natural frequencies of the rotor / propeller changes with RPM and may become equal to rotational speed.

FACULTY / AREAS OF EXPERTISE

Dr. Abhishek

PhD (University of Maryland, College Park) - Rotary Wing Aeromechanics, Autonomous MAV/UAVs, Wind Turbines.

Dr. Mangal Kothari

PhD (University of Leicester) - Optimal Control, Nonlinear and Adaptive Control, Flight Vehicle Guidance and Control, State Estimation, Motion Planning and Cooperative Control.

FACILITIES

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SECURING FINANCE NETWORKS THROUGH QUANTUM KEY DISTRIBUTION

SECURING FINANCE NETWORKS THROUGH QUANTUM KEY DISTRIBUTION

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> "The Internet must provide channels for secure, reliable, private, communication between entities, which can be clearly authenticated in a mutually understood manner"
>
> – Internet Society Organization

INFORMATION SECURITY BY QKD

Quantum Key Distribution (QKD) is a new approach to information encryption using keys generated by photons obeying well known principles of quantum mechanics. This radically new method of information encryption ensures higher levels of information security even against the most powerful malicious hackers.

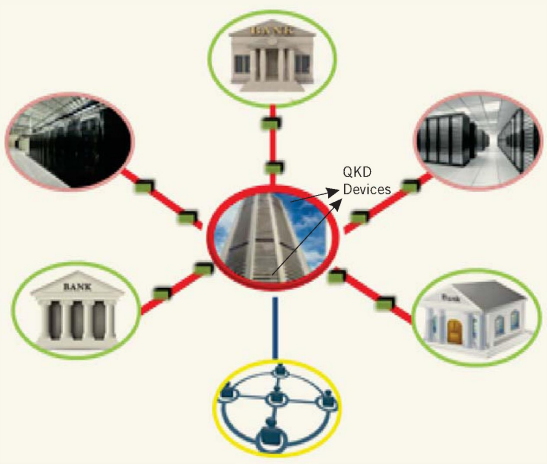
Classical methods of information security - classical cryptography - rely on non-availability/computationally expensive algorithms to break encrypted text. QKD relies on proven principles of quantum mechanics (uncertainty principle and no-cloning) to not only offer unconditional security but also to detect presence of eavesdroppers.

Potential market of QKD applications includes *finance networks (banks), power grids, and secure communications* all of which at present use classical cryptography.

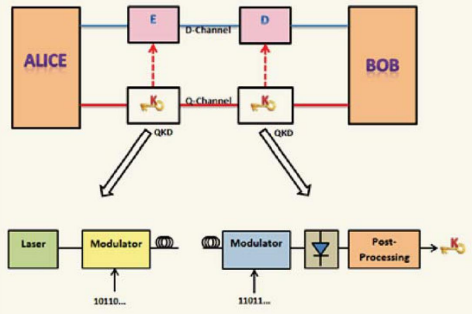
QKD solutions based on first generation protocols is now commercially available; however, the technology is not indigenous and needs to be imported. We have been working on QKD since last 8 years and have developed indigenous solutions that utilize off-the shelf optical components. This removes overhead of import costs.

Other benefits include

- Indigenous product
- Reduced cost as compared to present products
- Higher key rate and scalable infrastructure
- Increased security due to novel protocol



QKD for financial networks



Quantum Key Distribution Scheme

NEW TECHNOLOGY

Our QKD solutions

- Use single-photon/weak coherent sources for encryption
- Higher order modulation to increase key rate
- Coherent detection using single photon detectors
- Adaptable to subcarrier/OFDM multiplexing for high key rate applications

FACULTY / AREAS OF EXPERTISE

Dr. Pradeep Kumar
PhD (IIT Madras), Quantum Cryptography and Computation, Quantum and Nonlinear Optics, Fibre-Optics.

FACILITIES

Equipments: Agilent 40 GHz optical/65 GHz electrical sampling oscilloscope, Agilent optical spectrum analyzer, Agilent C- and L-band tunable laser source module, Agilent 8164B Mainframe with DFB laser and low power detector, Optiwave EDFA booster amplifier module, SRS 2.05 GHz RF signal generator, 400 MHZ oscilloscopes, Spartan v3 FPGA kits, Laser diode drivers.

Components (Optical): 3- and 4-port circulators, 4-port 50:50 splitters/couplers, C-band DFB laser diodes, Isolators, 980 nm Pump diode, EDF, Polarization controllers, fiber Bragg gratings, 4 and 16-channel WDM multiplexer/demultiplexer, 2 km standard single-mode fiber, 40 Gbps I/Q modulator, 40 GBps Intensity modulator, Optical patch chords and adapters, Lenses, Mirrors, Dichroic mirror, Polarization beam splitter, Wave plates, Mounts.

Components (RF): V-type (65 GHz) cable, SMA and V-type adapters, SMD Soldering station and Voltage/power supplies, Software for PCB design, FPGA programming, optical (FRED), COMSOL.

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RENEWABLE ENERGY

RENEWABLE ENERGY
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

> "A fuel cell system can be a truly zero-emission source of electricity, when the hydrogen is produced from non-polluting sources"

MARKET / RELATED PRODUCTS / BENEFITS

According to the statistical data from international energy agency, fossil fuels, i.e., petroleum oil, coal and natural gas contribute nearly 80% of our present energy requirements. In view of the increasing energy requirements and consequent depletion of fossil fuel resources, and the serious concerns for environmental sustainability caused by large-scale emissions of greenhouse gases, it is crucial to explore renewable energy sources and to utilize the available resources more efficiently. Among others, hydrogen is being explored as a renewable energy source to reduce the environmental concerns and to attain sustainability. A sustainable and emission free hydrogen energy cycle may be based on the production of hydrogen from electrochemical or photo-catalytic hydrolysis of water and the power generation from hydrogen by using fuel cells, the highly efficient, combustion-less engines.

Hydrogen-based fuel cells generate power by electrochemical route, which enables them to attain high power conversion efficiencies of ~80% as compared to those of 25-35% for most of the petrol/diesel internal combustion engines. The high efficiency makes fuel cells central to a clean, renewable energy economy. Fuel cells generate electricity using a fuel source such as hydrogen and air in an electrolytic reaction that results in pure water and some heat as waste products (**Figure 1a**). They have been used to generate electricity to power homes, buildings and also to provide motive power for cars, buses, motorcycles and fork-lift trucks (**Figure 1b, 1c**). When fuel cells are connected as part of a stack of cells they can provide adequate power for homes, offices and transport vehicles. The United States of America, Japan, South Korea and Germany have made significant investments and commitments to transition to a hydrogen economy using hydrogen fuel cells and a hydrogen supply chain to replace fossil-fuel based energy infrastructure. Among many fuel cell designs, the proton/polymer exchange/electrolyte membrane (PEM fuel cell is the leading candidate as it operates at average temperatures and intense research over the past few years has driven down costs of materials and improved performance and durability. Performance and cost of fuel cells will enable a faster transition to the hydrogen economy and also provide a significant competitive edge and source of revenues and jobs from a global market.

© http://www.hessen-nanotech.de

Figure 1. *Schematic showing fuel cell principle* ***(a).*** *Fuel cell powered music player* ***(b)*** *and bus* ***(c)***

NEW TECHNOLOGY

Cost efficient fabrication of fuel cell by using low-cost materials is the key to their commercial application. Components such as bipolar plats/end plates, polymer electrolyte membrane, gas diffusion layer and catalyst layer contribute more than 70% of the total cost of a PEM fuel cell. Hence, cost can be reduced by using novel materials and/or by adopting cost-effective fabrication techniques for these components. We have developed new materials to improve performance of the key catalysts needed to improve the electrolytic reaction in PEM fuel cells. Various catalyst layers consisting of low or no platinum loading were synthesized by using novel materials such as carbon nanotubes radially grown on carbon fiber, nitrogen and sulphur co-doped carbon synthesized by biowaste materials. Similarly, other parts of fuel cell such as the bipolar plates, gas diffusion layers and exchange membranes were also fabricated by using low cost materials. Finally, we have assembled fuel cells in our laboratories and verified the efficiency of oxygen reduction reaction and the output voltages in both humidified and non-humidified conditions with successful results (Figure 2).This should enable development of lower cost, higher performance PEM fuels cells than those available in the market today.

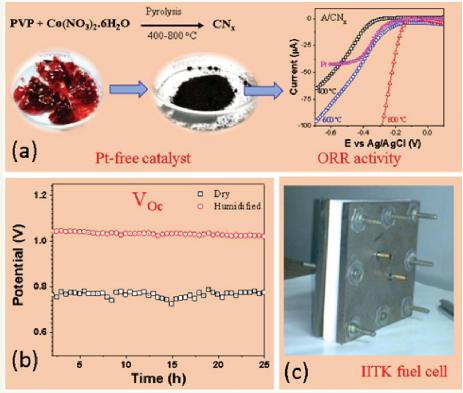

Figure 2: *(a) Oxygen reduction reaction (ORR) activity of N and O doped carbon, a Pt-free catalyst for fuel cell cathode. (b) Performance of fuel cell in terms of open circuit voltage (VOc). (c) Photograph of fuel cell fabricated completely at IIT Kanpur.*

FACULTY / AREAS OF EXPERTISE

Dr. Kamal K. Kar
Applications of novel and conventional materials in solar cell, fuel cell, lithium battery, thermoelectric, thermionic, supercapacitor, water purification, high performance structural composites, catalysis, destruction of cancer cells, roadwheel of Military Battle Tank Arjuna.

Mr. Raghunandan Sharma
Nanostructured carbon as catalyst support and cathode catalyst for low-temperature fuel cells, device applications of carbon nanotubes, electrocatalysis.

Dr. Malay K
Marine hydrates, CH4 recovery and CO2 sequestration; electrochemical energy conversion, fuel cells, batteries, solar H2 generation; bio-fluid mechanics, hydrodynamic stability.

Dr. J. Ramkumar
Micro/nano manufacturing and machining, composites.

FACILITIES

Facilities related to material synthesis: Chemical vapour deposition, hot press, hot isostatic press, injection molding, sonicator. Characterization techniques: Electrochemical characterization for catalysts: potentiostat (CH instruments), RDE setup, electrochemical cell attached to AFM. Structural characterizations: SEM, AFM, DSC, TGA / DTA, Raman spectroscopy. Mechanical characterizations: UTM, micro hardness, DMA.

Contact

Prof. Kamal Kar
Phone: +91-9415081153, E-mail: kamalkk@iitk.ac.in

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ENERGY CONSERVATION

ENERGY CONSERVATION
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MARKET / RELATED PRODUCTS / BENEFITS

Energy efficiency is a key element of national energy policy. Ensure efficient use of energy is a more cost efficient means to reduce the dependence on imports, the use of fossil fuels and the emissions leading to climate change and health costs. A recent study in the United States showed a potential reduction of 23% of annual energy consumption resulting in a $1.2 trillion reduction on energy costs. Energy efficiency is recognition that wasteful use of precious resources is unacceptable and takes a toll on the entire nation. Lighting accounts for over 10% of electric power used in a home or office building. Improving lighting efficiency and reducing costs can go a long way in reducing energy use and emissions.

Use of incandescent lamps is still relevant due to their low manufacturing cost and high color rendering index compared to other light sources such as compact fluorescent lamps. The light produced by the bulbs resembles closely to a blackbody radiation and hence it reproduces colors exactly. Moreover, use of substances such as mercury vapor makes fluorescent lamps potentially health hazardous. Hence, improving lighting efficiency of incandescent lamps by adopting energy efficient design is of significant importance for energy conservation.

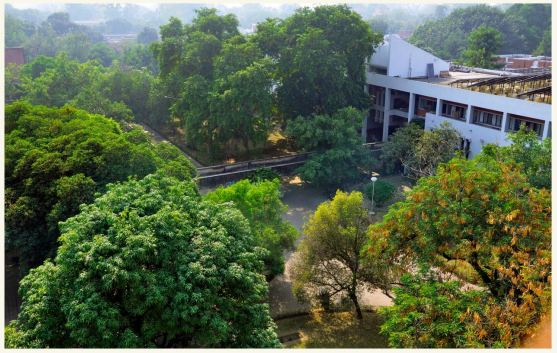

Figure 1. *Energy efficient design*

NEW TECHNOLOGY

We have developed technology that uses multi-wall carbon nanotubes (MWCNTs) to complement tungsten filaments in lamps to improve the luminosity of filament lamps. Easy fabrication of the filaments was attained by coating straight or coiled MWCNTs on tungsten filament. Our results have shown a significant increase in luminosity of MWCNT coated tungsten filament lamps relative to the current industry standard tungsten filament lamps. Moreover, coiled MWCNT coated filaments show even higher performance compared to straight MWCNT filament lamps. This technology promises to dramatically reduce power usage for lamps at no additional cost to the consumer.

Another technology has been made to replace tungsten filament with a hierarchically structured, carbon-based filament consisting of MWCNT coated carbon fiber. The CNT-based filaments show higher performance compared to industry standard tungsten filament lamps (Figure 2).

Contact

> "Energy efficiency offers a vast, low cost energy resource"
>
> – McKinsey & Co

FACULTY / AREAS OF EXPERTISE

Dr. Kamal K. Kar

Applications of novel and conventional materials in solar cell, fuel cell, lithium battery, thermoelectric, thermionic, supercapacitor, water purification, high performance structural composites, catalysis, destruction of cancer cells, road wheel of Military Battle Tank Arjuna.

Mr. Raghunandan Sharma

Nanostructured carbon as catalyst support and cathode catalyst for low-temperature fuel cells, device applications of carbon nanotubes, electrocatalysis.

FACILITIES

Facilities related to material synthesis: Chemical vapour deposition, hot press, hot isostatic press, injection molding, sonicator. Characterization techniques: Electrochemical characterization for catalysts: potentiostat (CH instruments), RDE setup, electrochemical cell attached to AFM. Structural characterizations: SEM, AFM, DSC, TGA/DTA, Raman spectroscopy. Mechanical characterizations: UTM, micro hardness, DMA.

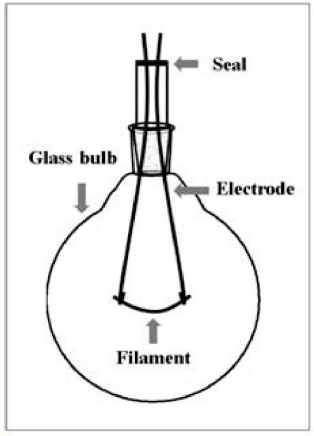

Figure 2a. *Schematic of bulb*

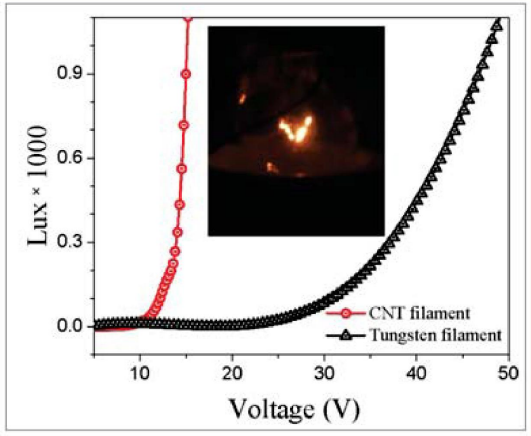

Figure 2b. *performance of CNT coated carbon fiber filament compared to tungsten filament*

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Declaration

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INDIAN INSTITUTE OF TECHNOLOGY KANPUR

BIG DATA ANALYTICS PERFORMANCE

BIG DATA ANALYTICS PERFORMANCE

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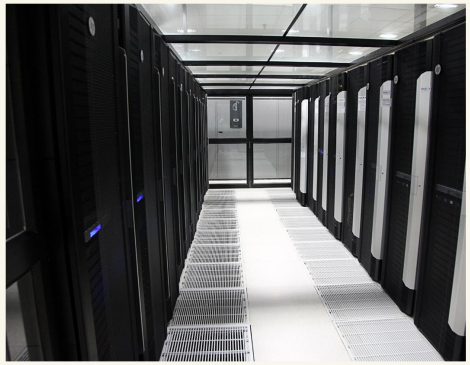
> **Big Data represents the Information assets characterized by such a High Volume, Velocity and Variety to require specific Technology and Analytical Methods for its transformation into Value**
>
> – Wikipedia

MARKET / RELATED PRODUCTS / BENEFITS

In the past few years we have seen a veritable explosion in various ways to store and retrieve data. NoSQL databases have been leading the charge and creating all these new persistence choices. These alternatives have, in large part, become more popular due to the rise of Big Data led by companies such as Google, Amazon, Twitter, and Facebook as they have amassed vast amounts of data that must be stored, queried, and analyzed. But more and more companies are collecting massive amounts of data and they need to be able to effectively use all that data to fuel their business. For example, social networks all need to be able to analyze large social graphs of people and make recommendations for whom to link to next, while almost every large website out there now has a recommendation engine that tries to suggest ever more things you might want to purchase. As these businesses collect more data, they need a way to be able to easily scale-up without needing to re-write entire systems.



Since the 1970s, relational database management systems (RDBMS) have dominated the data landscape. But as businesses collect, store and process more and more data, relational databases are harder and harder to scale. HBase is an open-source database that provides real-time, random read and write access to tables meant to store billions of rows and millions of columns. It is designed to run on a cluster of commodity servers and to automatically scale as more servers are added, while retaining the same performance. In addition, it is fault tolerant precisely because data is divided across servers in the cluster and stored in a redundant file system such as the Hadoop Distributed File System (HDFS). When (not if) servers fail, your data is safe, and the data is automatically re-balanced over the remaining servers until replacements are online. HBase is a strongly consistent data store; changes you make are immediately visible to all other clients. HBase is modeled after Google's Bigtable, which was described in a paper written by Google in 2006 as a "sparse, distributed, persistent multi-dimensional sorted map." HBASE is extremely scalable, reliable and flexible but with many moving parts comes at the price of huge complexity.

NEW TECHNOLOGY

Column-oriented data stores, such as BigTable and HBase, have successfully paved the way for managing large key-value datasets with random accesses. At the same time, the declining cost of flash SSDs have enabled their use in several applications including large databases. In this paper, we explore the feasibility of introducing flash SSDs for HBase. Since storing the entire user data is infeasible due to impractically large costs, we perform a qualitative and supporting quantitative assessment of the implications of storing the system components of HBase in flash SSDs. Our proposed HYBRID HBASE system performs 1.5-2 times better than a complete disk-based system on the YCSB benchmark workloads. This increase in performance comes at a relatively low cost overhead. Consequently, Hybrid HBase exhibits the best performance in terms of cost per throughput when compared to either a complete HDD-based or a complete flash SSD-based system.

FACULTY / AREAS OF EXPERTISE

Dr. Arnab Bhattacharya

Ph D (University of California, Santa Barbara), Databases, Data Mining, Sensor Networks, Bioinformatics, Data Streaming, Security, Discovery, Learning, Cognition

FACILITIES

Machines configurable to set up a Hadoop cluster.

Contact

Dr. Arnab Bhattacharya
Phone: +91 (512) 259-7650, E-mail: arnabb@iitk.ac.in

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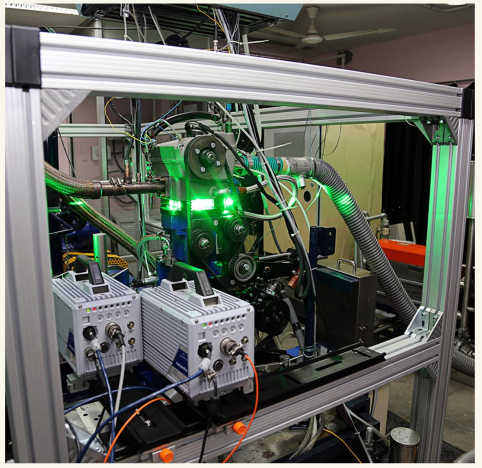


IC ENGINE DEVELOPMENT

IC ENGINE DEVELOPMENT
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

MARKET / RELATED PRODUCTS / BENEFITS

Automotive, diesel / gasoline engines for locomotives and power generation.

NEW TECHNOLOGY

Internal combustion engine fuel efficiency, emission controls, engine durability and new engine development, spray development, ECU calibration, Optical diagnostics, emission reduction.

FACULTY / AREAS OF EXPERTISE

Dr. Avinash Agarwal

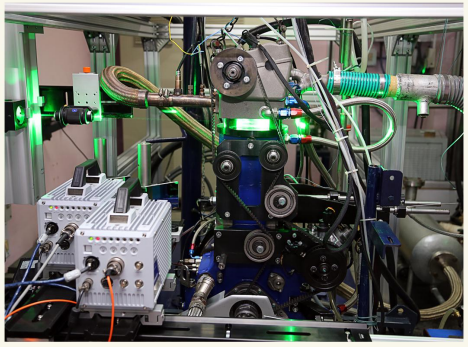
Dr. Tarun Gupta

Dr. Sujit Sinha

Dr. Nachiketa Tiwari

Dr. Bishakh Bhattacharya

- Experimental investigations of HCCI / PCCI combustion in a single cylinder research engine using convention fuels and bio-fuels.
- Alcohol fuelled engines and vehicles, test bed development and field trials.
- Experimental investigations of combustion and emissions of a laser fired hydrogen engine.
- Experimental investigations of fuel sprays of biodiesel, straight vegetable oils and their blends with mineral diesel.
- Optical diagnostics and combustion visualization endoscopy of biodiesel fuelled direct injection engine.
- Development of a common rail injection system for a constant speed compression ignition engine.
- Combustion, material compatibility and engine tribology investigations in biodiesel fuelled turbo-charged transportation engine.



Contact

> **With federal fuel-economy standards getting tougher by 35 percent over the next five years, IC efficiency must improve dramatically—if not, we'll all be forced to drive econoboxes**
>
> – Car & Driver Magazine

FACILITIES

Single Cylinder Optical Research Engine (SCORE)

- SCORE is a flexible engine system with adjustable fuel injection strategies, injection timing, boost pressure, and compression ratio.
- SCORE has provision for control and measurement of fuel injection pressure, injection pattern (two pilot, one main and one post injection).
- For combustion visualization, it has transparent quartz liner and quartz window in the piston crown.

Laser Related Investigations

- Major research areas include development of laser ignition system, 2D, 3D and tomographic time resolved particle imaging velocimetry (PIV) and phase doppler interferometry (PID).
- PIV is a non intrusive technique, which measures whole velocity field by taking two images shortly one after the other and can be employed in an optical engine.
- PDI technique allows simultaneous measurement of droplet size distribution and the three components of velocity by measuring the phase difference and frequency of the light scattered by droplets in a fuel spray.

Data Acquisition System

- ERL has a custom built data acquisition system, which is capable of measuring all combustion parameters, in addition to systems for raw combustion data acquisition and analysis.

Emission Measurement Equipment

- ERL has world class emission characterization systems for regulated and unregulated gaseous emission species. These equipment are capable of measuring regulated pollutant species like NOx, CO, CO_2, HC and smoke opacity in addition to 31 unregulated species, using FTIR emission analysers.

Oil Testing Facility

- ERL has advanced oil testing facilities, which are capable of measuring various properties of lubricating oils and fuels. Using these facilities, physical, chemical and other important properties of fuels and lubricating oils can be accurately measured for comparative analysis.

Biodiesel Pilot Plant

- We have designed and developed a low cost (< Rs 10 lakhs) biodiesel pilot plant.
- Additionally, developed a biodiesel operated car, which can operate on 100% biodiesel as well as its blends with mineral diesel.

Dr. Avinash Kumar Agarwal
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INDIAN INSTITUTE OF TECHNOLOGY KANPUR

RENEWABLE ENERGY

RENEWABLE ENERGY
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

MARKET / RELATED PRODUCTS / BENEFITS

Our country uses a lot of energy to power our homes, offices and for transportation (cars, buses, motorcycles, trains). About 70% of the electricity generated is from coal, we are the fourth largest importer of natural gas used at home for cooking, as CNG for transportation also for power generation. We are the third largest importer of oil in the world which contributes to our emissions and also the nation's balance of payment. However, today's energy use based on the conversion of fossil fuels is not sustainable in the long run. Besides, global warming, security of supply and local air quality are strong driving forces to change the present energy system. Hydrogen plays a pivotal role in all strategies to lower emissions and increase the possibilities of covering the energy demand with sustainability. The path to an energy future independent of fossil fuels will include the use of hydrogen, fuel cells and a new hydrogen supply chain.

The key technologies to enable this include hydrogen generation, storage, transportation and fuel cell development. In the European Union, the USA and Japan, the hydrogen and fuel cell platform has set up a strategic research agenda aimed at the development of technologies needed for hydrogen production, storage, transport and applications in mobile as well as stationary systems. New technologies promise to increase efficiencies and lower costs even further to make the transition to this new energy era more cost effective.

Contact

> **"The search for high-capacity hydrogen storage materials remains a highly competitive area of research: the race is on to develop MOFs that can meet all of the targets set by the Department of Energy"**

NEW TECHNOLOGY

Finally, MOFs hold the promise for hydrogen generation by its use as a photocatalyst for water splitting using solar energy. Hydrogen evolution using MOFs as catalysts is an essential half-reaction in water splitting that converts solar energy into chemical potential of hydrogen molecules. In this endeavor, semiconducting metal ions and special linkers holds high promise that is yet to be realized.

Metal organic frameworks (MOF) have become extremely viable and attractive for use as material for hydrogen storage. Their unique features such as designable architecture, controllable pore size, shape, high surface area, permanent porosity are important factors for hydrogen storage. Aside from the large number of possible combinations of different SBUs and organic linkers, the presence of exposed metal coordination sites within the pores has also been exploited. Presently, the paradigms of maximizing hydrogen gas adsorption and the interaction energy for reversibility of storage are being probed.

It is only recently that the technical advances necessary for the application of hydrogen fuel cells for domestic transportation have put us within reach of a hydrogen-fuelled future. In recent times, MOF are attracting increasing attention for potential uses in fuel cells as proton conducting separator materials to replace the existing proton exchange membrane, Nafion. MOF also have potential uses as proton exchange membrane to increase proton conductivity at higher temperatures. In addition designability of channels allows control over loading of guest proton carriers in to channels to increase proton conduction.

FACULTY / AREAS OF EXPERTISE

Dr. Bharadwaj

Dr. Sabuj Kumar Kundu

Dr. DVLK Prasad

Dr. Pratik Sen

FACILITIES

Facilities required for synthesis and characterization are available. Equipments required for measuring gas adsorption are required.

Dr. P. K. Bharadwaj
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INDIAN INSTITUTE OF TECHNOLOGY KANPUR

ENVIRONMENTAL CONSERVATION - WASTE WATER TREATMENT

ENVIRONMENTAL CONSERVATION - WASTE WATER TREATMENT

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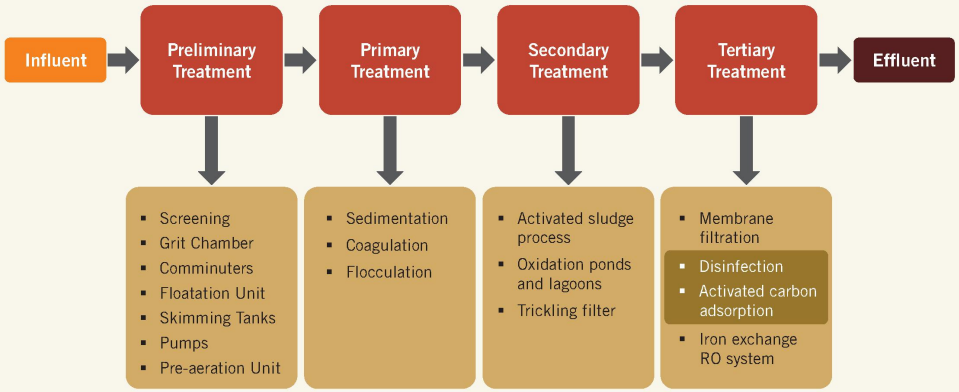


MARKET / RELATED PRODUCTS / BENEFITS

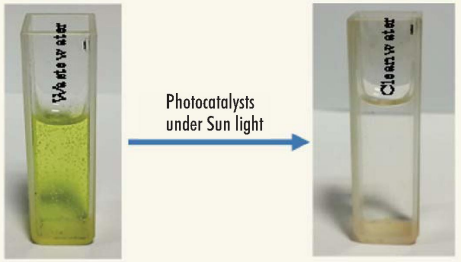
Industrialization results in many types of pollution such as water, air and sound pollution. Only 3% water is available as fresh water. India has 16% of world's population, but contains only 4% of world's water resources. Water resources variation is huge with space, 71% of the resources are existing to 36% of the area. An Ernst & Young (E&Y) study says the Indian water sector could require investment of around $130 billion between 2011 and 2030. According to industry estimates, Indians on average use 120 to 125 litres (33 gallons) of water daily, about half of this becomes wastewater. If harnessed, this can generate 940 MW power. Waste water treatment is an important issue and needs to be taken care for a healthy environment. Wastewater treatment involves a series of processes for removing a variety of contaminants from water and making it reusable. Treated water can be used as a process water, make-up water (cooling loops, boilers, fire fighting, washing / rinsing / wash down), non-potable water (restrooms landscape irrigation, decorative water features) depending upon the contamination type.

Contact

> "I come from a poor family and I want the poor to get dignity. We want to start a movement for a clean India. If we have to build a nation, let us start from the villages"
>
> – Narender Modi
> *Prime Minister of INDIA*

COMPANIES WORKING IN THE FIELD

Over 250 companies are operating in the field of water and waste water treatment. Out of these, around 20-30 companies are operating at a large scale and provide wide range of products and services across India. There are many medium and small scale companies operating locally, with limited product and solution ranges. Key companies includes VA Tech Wabag, Thermax, GE Water, Siemens Water, Voltas Limited, Hindustan Dorr Oliver Limited, Wog Technologies, UEM Private Limited, SFC Environmental Technologies Private Limited, Ion Exchange India Limited, Doshion Veolia Water Solutions, Driplex Water Engineering Limited, Degremont, Praj, Aquatech, Paramount Limited, Veolia Water, Bestech India Private Limited, Aqua Filsep Inc. and Fontus Water. Some of these companies have their manufacturing setup at more than one location and some companies are having collaborations with international organizations for technical assistance. Waste water treatment costs have been reduced through development of advance process (RO membranes, advance oxidation processes, and adsorptive removal) and new technologies. Hitachi (HPT) (Japan), Voltas, IDE Technologies Ltd (Israel) and Hilux Ltd. (HYF) (Singapore), Abengoa SA (ABG) (Spain) are new companies who have started working in the field of waste water treatment in India. There are several types of commercial product from different company such as Kent, Aqua Guard, Tata Swach.



NEW TECHNOLOGY

We require good adsorbent, catalyst and photocatalyst for better degradation of (industrial, residential, commercial) wastes into nontoxic and eco-friendly compounds. Adsorbent works on physically or chemically adsorption of pollutant. Activation carbon adsorption and advanced oxidation process are most promising technologies over the years. Photocatalysis is one of most prominent process for water purification. Photocatalysis is a cheaper process and utilizes the Sun, a renewable source.

FACULTY / AREAS OF EXPERTISE

Dr. Raju Kumar Gupta, others

Our group has developed variety of nanomaterials having solar absorption from UV / Vis to near-infrared (NIR) wavelength region and tested them as photocatalysts for variety of model organic pollutants like p-nitrophenol, methylene blue and rhodamine-B. Such nanomaterials have the potential to utilize them for industrial waste water treatment.

FACILITIES

Solar Simulator, Zeta Potential Measurement, UV Chamber, Furnaces (tubular and muffle).

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Tel: +91 512 259 6972 | Email: guptark@iitk.ac.in