DEAN'S MESSAGE



Dear Alumnus,

I'd like to take you through some of the key events that took place at the Institute over this past month:

1. The 63rd Annual Foundation Day celebrations were held on March 10, 2022 at IIT Bombay's campus.

The Institute recognised distinguished alumni members who have excelled in their professional fields with the Distinguished Alumnus Awards (DAA), as well as the Young Alumni Achiever Awards (YAAA), which were given to young outstanding alumni members who are below 40 years of age.

It was extremely heart-warming to see our alumni members and awardees accompanied by their parents. The happiness our alumni felt was nothing compared to the pride and smiles on their parents' faces when they saw their children being honoured and receiving their awards amid their peers, senior Institute officials and other dignitaries who graced the occasion.

The Institute also introduced three key ongoing projects on the Foundation Day. They include:

- Enhancement and upgradation of Hostel 5 through a joint initiative called 'Enhancement of Oldest Hostels' between the Institute and IIT Bombay Alumni Association.
- The 'IIT Bombay Women Gen Zero Project' that highlights and applauds the incredible accomplishments of 30 women alumni from the Institute.
- The 'Stay Connected Initiative', where alumni members are encouraged to update their contact information on a dedicated online portal called 'Stay Connected,' so that they can get the latest news, activities, initiatives and events happening at their alma mater.

The Chief Guest at the event was Dr. Anil Kakodkar, a renowned nuclear physicist and mechanical engineer, and who also served as the Chairman of the Board of Governors at IIT Bombay.

The Foundation day celebrations also celebrated the awards instituted by two distinguished IITB alumnus, Mr. Rakesh Mathur, who has funded two Research Excellence Awards titled Prof. H.H. Mathur award and the Prof. S. C. Bhattacharya awards over the years. The awards for this year's recipients were presented during the Foundation Day celebrations on:

- Prof. Jayesh Bellare, Department of Chemical Engineering, was conferred the 'Prof. H. H. Mathur Award for Excellence in Applied Sciences'
- Prof. Jugal K. Verma, Department of Mathematics, was conferred the 'Prof. S. C. Bhattacharya Award for Excellence in Pure Sciences'

Our heartiest congratulations to Prof. Bellare and Prof. Verma!

3. The Institute has launched a new academic program, Master of Arts by Research, MA (Res). The academic program will commence in July 2022 and will focus on three broad specialisations: 1) Human Sciences 2) Linguistics, Literature and Performance and 3) Sociology. The curriculum will focus on 'research' skills which are not just essential for students as they navigate their lives in academia but are equally important in the workplace. IIT Bombay looks forward to welcoming a fresh cohort of students to its new academic program.

4. The construction of Hostel 17 has finally concluded, and was inaugurated on the 27th March, 2022 by Shri. Dharmendra Pradhan, Minister of Education and Minister of Skill Development and Entrepreneurship. We are optimistic that students will be able occupy the hostel by the end of April 2022.

5. On the faculty achievement front, I would like to congratulate Prof. Prasanna Gandhi, Dept. of Mechanical Engineering and his team for receiving the "Technology Translation Award" from SERB (SERB-TETRA). This award recognises their work titled, "Method Apparatus for dynamic amplification of motion with frictionless precision guidance". Prof. Arpita Mondal will be featured in the second edition of the 'She Is' book series published by the Office of PSA, Govt of India and the Red Dot Foundation featuring 75 Women who work in STEM in India. I extend my heartiest congratulations to her.

6. IIT Bombay's distinguished alumnus, Mr. Deepak M. Satwalekar (B.Tech – Hons, Mechanical Engineering, 1971), has committed to contributing generously towards the setting up of a Design and Making Lab at the Institute. A Memorandum of Understanding (MOU) was signed on March 10, 2022, between IIT Bombay and Mr. Satwalekar. The Lab will be named the "Deepak and Maya Satwalekar Lab (Design and Making)" to honour Mr. Satwalekar's philanthropic donation, and will be located on the first floor of the Pre-Engineered Transit Building on campus. The purpose of this initiative is to facilitate new ways of learning for first-year engineering students at the Institute. Students will gain access to top-of-the-line class equipment for mechanical and electronic work including 3D printers, latest workstations with CAD (Computer-aided Design software), and a complete electronics setup.

7. The Gymkhana elections were conducted smoothly on 26th March, 2022, and the provisional results for the Institute's General Secretaries have been announced. I would like to extend my heartiest congratulations to the winners, and wish them all the best for their tenure.

I urge all of our alumni members to contribute to the various projects currently underway at IIT Bombay. The alumni community from nearly 60 batches of the Institute have come together to design, fund and construct a world-class hostel complex on campus. This venture is titled 'Project Evergreen' and is the largest ever alumniled initiative and needs your active involvement and philanthropic contributions to fulfil its ambitious target.

On that note, I would like to thank you for your continued support and generosity. I am confident that a vibrant and involved alumni community is key to the betterment of IIT Bombay.

Sincerely, Prof. Ravi Gudi Dean ACR



SPECIAL FEATURE

Arpit Mathur: His Journey from Privilege to Philanthropy

He's a super-successful high-flying asset manager whose career has taken him all over the world. Beyond those professional triumphs lies Arpit Mathur's core life philosophy and he says, "I've been very fortunate in my life. But if I don't use my good fortune and pay-it-forward to help people and our society, then what's the point?"

Arpit's Foray into Philanthropy

Arpit's philanthropic journey began at home where his parents inculcated the importance and the responsibility that comes with having privilege. His family was rooted in social work and giving back to society was integral to them. Arpit's mother was passionate about elevating and empowering the girl child. Tragically, Arpit lost his mother last year during the second wave of COVID.

Unsurprisingly, one of Arpit Mathur's two major endowments to his alma mater included paying homage to the woman who played such an influential part in his life. The Renuka Mathur Scholarship was instituted in his mother's name and will provide scholarships to women students at IIT Bombay.

Becoming a Founding Donor for C-MInDS

Arpit's second endowment to IIT Bombay brings his academic life a full circle. As a dual-degree Computer Science student who graduated in 2006, Arpit was fascinated with Artificial Intelligence (AI) and Data Sciences (DS). While, typically, it's big-tech giants who explore possibilities through AI, Arpit wishes to exploit AI to benefit people in remote parts of India who currently have limited access to technology and infrastructure. In his view, this is feasible only if the possibilities of AI are studied by experts from various disciplines of academia. In C-MInDS (The Centre for Machine Intelligence and Data Science, IIT Bombay) he saw his vision come to life where IIT Bombay's interdisciplinary approach brought together members from diverse fields like Biotech, Humanities etc. to explore innovations that can serve the needs of mankind.

It was, therefore, a straightforward decision for Arpit to become a Founding Donor of C-MInDS.

While philanthropy is at the core of Arpit's life, it was also deeply important for him to give back to his alma mater. "Whatever little I have achieved today is because the IIT Bombay brand is the single biggest name I have on my CV," he says with pride and heartfelt gratitude.

Arpit's Career Trajectory

So, how did he get here? After graduating from IIT Bombay in 2006, Arpit joined Lehman Brothers and was soon transferred to their London office. Unfortunately, a life filled with dreams and aspirations came to a grinding halt when within six months of moving to London, the company filed for bankruptcy. A break of a lifetime turned into a nightmare when Arpit found himself in a brand-new country with no job and no support system, either.

But Arpit thoughtfully used this time to pursue a Master's Degree in Financial Engineering at UC Berkley. After a year in California, Arpit returned to London, then moved to Sydney where he worked in Asset Management, before making his way to Exodus Point in Singapore in 2020, where he still works.

Arpit's mantra for success is what he learned as a student at the Institute:

"I was surrounded by supersmart people in Computer Science at IIT Bombay. No matter how much you think you know, you look over your shoulder and there's someone smarter. Just be humble. I live by that motto even today," he says clearly.



Arpit – The Family Man

But beyond all else, Arpit is very much a family man. Arpit's biggest joy and stress buster is spending time with his children. For a man at the forefront of life, Arpit's favorite place to be is on the sidelines, watching his kids swim or play soccer.

His children also play a significant part in Arpit's philanthropic journey. "What do you tell your kids after you retire? It doesn't matter how much money you've earned or what position you've reached. What matters most is to tell them about what you valued most – that

for me is about how I've been able to contribute to the betterment of society."

Onwards and Upwards

There are so many ways to describe Arpit Mathur: Asset Manager. Philanthropist. Husband. Father. Son. IIT Bombay alumnus. Irrespective of where life takes him, undoubtedly, Arpit will continue to do good – not just for himself, but for the world around him, as well.

And as much as his alma mater is proud of what Arpit has already achieved, the Institute cannot wait to see what else he will accomplish, moving forward.

Onwards and upwards, Arpit!

FACULTY INTERVIEW



Prof B. Ravi: On a mission to strengthen the ecosystem for med-tech innovation and entrepreneurship

IIT Bombay is home not only to world-class researchers, but the Institute has also established some of the finest innovation centres in the country. The Biomedical Engineering & Technology Innovation Centre (BETIC) is one such interdisciplinary innovation centre, which has

created a comprehensive ecosystem by connecting stakeholders – academia, the medical community, government, industry, investors, and facilitators.

Today, we present the founder of BETIC, Prof B. Ravi.

Prof. B. Ravi is an Institute Chair Professor of Mechanical Engineering at IIT Bombay, and the principal investigator of BETIC. He also heads the Desai-Sethi School of Entrepreneurship. Read on to know more about his inspiring journey and his commitment to growing and advancing the entrepreneurial ecosystem at IIT Bombay.

Prof. Ravi, can you briefly describe BETIC to those who may not know about it?

Prof. Ravi: BETIC was established at IIT Bombay in 2014 with the support of the Maharashtra Government. It started with a small team and a modest goal – bring doctors and engineers under one roof to explore innovations in the medical device sector. Since its inception, BETIC has grown immensely and now has a robust network of 15 centres that have developed 240 innovative devices, patented over 60 technologies, and licensed the technologies to 30 start-up companies and industry partners. Some start-ups have garnered tremendous success, such as the smart stethoscope of Ayu Devices.

You have constantly emphasised indigenous product innovation. Why do you think it's the need of the hour to innovate locally in our country?

Prof. Ravi: India's annual requirement for medical devices is worth over Rs. 50,000 Cr. Eighty percent of this requirement comes from the US, Europe, and the Far East. However, our per capita expenditure on healthcare is less than 1% of America. As a result, imported devices are too expensive for the common man. Moreover, they are designed for the anatomy and functionality of the western population. It is therefore critical for us to develop novel products indigenously that are suitable and affordable for the local population.

What are some of the key roadblocks faced by entrepreneurs as they move from innovating and prototyping to manufacturing and marketing the final product?

Prof. Ravi: The biggest 'Valley of Death' is translating research prototypes into marketable products. Researchers in academic institutes usually do not have the necessary domain expertise and facilities for this purpose. Industry does not come forward due to the inherent perceived risk.

Once product development is complete, the next big roadblock is regulatory clearances. BETIC addressed this by establishing a quality management system for medical devices as per globally recognized ISO 13485 standard. This greatly eased the path for obtaining necessary approvals from government agencies and convincing partner hospitals to conduct human clinical trials.

Funding required to scale up the business operations and compete globally continues to be another gigantic challenge for the start-ups in med-tech domain.

As head of BETIC, can you elaborate on product innovation in the medical sector?

Prof. Ravi: Given the high rate of failures from idea to invention, invention to innovation, and innovation to impact, we have evolved and implemented a systematic approach to overcome the challenges mentioned.

This approach, which we call '4D', includes the follows stages:

(i) defining an unmet need after immersion in hospitals and observing the end-users

(ii) developing a novel solution that has high suitability, manufacturability, and affordability

(iii) delivering a validated device with biological, mechanical, and electrical safety

(iv) deploying the device by licensing the technology to a start-up or local industry partner.

What are some real-life practical steps that can be taken for collaborating and accelerating medical technology innovation in the future?

Prof. Ravi: Frankly, the doctors, researchers, engineers and entrepreneurs do not fully understand all steps in the innovation lifecycle of medical devices. The need of the hour is to create a conducive environment for the stakeholders to meet and collaborate under one roof. These meetings will help them know their individual roles and jointly navigate the 'Valleys of Death' starting from bedside to bench, bench to business, and business to bedside.

What are some initiatives being undertaken to instil entrepreneurship at BETIC and promote medical technology innovation? How exactly does BETIC help students, recent graduates or alumni members who wish to pursue developing and marketing a product?

Prof. Ravi: BETIC conducts Medical Device Hackathons (MEDHA) every year in various engineering and medical colleges. These hackathons bring local doctors and engineers together to define unmet medical needs and develop novel solution ideas. Selected participants are further trained at Medical Device Innovation Camp (MEDIC) at IIT Bombay.

In last six years, we organised 13 MEDHA and 6 MEDIC in association with other partner institutes. These events benefitted more than 1000 students from engineering and medical backgrounds, as well as teachers, innovation/incubation managers, entrepreneurs, and industry professionals. Some of the participants later joined BETIC centres to continue the journey and incubated their own start-ups.

What are some of BETIC's biggest successes so far?

Prof. Ravi: I am delighted to share that 10 products developed at various BETIC centres have reached the market. The list includes a smart stethoscope, orthopaedic surgery planner, diabetic foot screener, above-knee prosthesis, knee ankle foot orthosis, instant splint, endotracheal blockage detector, temporal bone phantom, craniofacial implants, and surgery guides. The smart stethoscope was initially developed for telemedicine in rural hospitals. During the pandemic, it proved highly beneficial for remote auscultation and monitoring of COVID patients. The start-up has already sold over 4000 units.

What advice would you give students who are eager to make the transition from being students into becoming successful entrepreneurs in the future?

Prof. Ravi: In order to become successful entrepreneurs, the students and researchers need to enhance several skill sets. First, is the ability to spot an opportunity and develop a creative problem-solving attitude. Basic knowledge of marketing and finance is critical. They need to develop excellent communication skills and learn to build strong teams. Above all, they should prepare themselves to embrace failures and fight for their dreams.

Aspiring student-entrepreneurs could enrol in the "Introduction to Entrepreneurship" course and the IDEAS mentoring program offered by the Desai Sethi School of Entrepreneurship at IIT Bombay. An 'entrepreneurial mindset' is useful and valuable in any career.

Thank you, Prof. B. Ravi for speaking with us and giving our readers an insight into how BETIC works. Your practical advice for entrepreneurs is extremely insightful and advantageous to all of us.

NEWS FROM IIT BOMBAY



Alok Maskara, IIT Bombay Alumnus named CEO of Lennox International Inc.

IIT Bombay's alumnus, Mr. Alok Maskara (B.Tech., Chemical Engineering, 1992), has been appointed as CEO of Lennox International Inc., a global leader in energy-efficient climate-control solutions. His responsibilities as CEO will include driving the longterm growth and profitability of the company and advancing the company's overall position within the industry.

After completing his education at IIT Bombay, Mr. Maskara pursued

his M.S. in Chemical Engineering from the University of New Mexico, USA, and an MBA from the J.L. Kellogg Graduate School of Management at Northwestern University, USA.

Until recently, Mr. Maskara was President of Technical Solutions, the global business segment of Pentair PLC. Mr. Maskara worked at Pentair for eight years, serving as President of progressively larger international business units within the company, including Residential Filtration (2008-2011), Water Purification (2011-2012) and Thermal Management (2012-2014).

The Institute extends its congratulations and warm wishes to Mr. Alok Maskara.



Raj Subramaniam, IIT Bombay Alumnus, to be New FedEx President

IIT Bombay alumnus Mr. Raj Subramaniam (B. Tech, Chem. Engg. 1987) has been appointed as the new Chief Executive Officer of FedEx. He will replace Mr. Frederick W. Smith, chairman and CEO, who will step down from this position on June 1, 2022.

Mr. Subramaniam, a native of Trivandrum, Kerala, did his schooling at Loyola School in Thiruvananthapuram. After completing his B- Tech from IIT Bombay, he moved to the US and got his MS in Chemical Engineering from Syracuse University in 1989. He later pursued his MBA in Marketing/Finance from the University of Texas at Austin.

Mr. Subramaniam joined FedEx in 1991. In his long and illustrious career at FedEx he's held several management and marketing roles throughout Asia and the US. Prior to being appointed as CEO of the global delivery giant, Mr. Subramaniam served as the President and COO of the company and became a member of the FedEx Board of Directors in 2020.

The Institute extends its congratulations and warm wishes to Mr. Raj Subramaniam.



Book lauds scientists from IIT Bombay

Dr. Jitendra Singh, Minister of State (Independent Charge), Science & Technology, released three coffee-table books published by Vigyan Prasar on National Science Day to mark "Vigyan Sarvatra Pujyate".

The book, "75 under 50: Scientists Shaping Today's India" includes

three young scientists from IIT Bombay. Prof. Subimal Ghosh (Department of Civil Engineering and Convenor of IIT Bombay Climate Studies), Prof. Anshuman Kumar (Department of Physics), and Prof. Rohit Srivastava (Head of Department of Biosciences and Bioengineering) were recognised for their outstanding contributions in their respective scientific fields.

The book delves into the personal lives and professional accomplishments of 75 scientists, and offers an indepth look at their diverse backgrounds, what motivated them to become scientists, the many challenges they faced in their careers, and more.



IIT Bombay introduces a new academic program, Master of Arts (Research) – MA (Res)

The Humanities and Social Sciences department at IIT Bombay is introducing a new academic program, Master of Arts by Research (MA. Res).

India's higher education system is in dire need of programmes that focus on 'research' skills which are necessary not just in academia

but also in the workplace and industry. These skills include learning to read, think and write critically, integrate diverse sources of information, and apply conceptual, analytical, and methodological frameworks to their research. The Master of Arts by Research has been designed to equip students with the research skills they need to pursue their careers effectively.

The diverse group of faculty members in the department have experience with interdisciplinary teaching, as well as the requisite expertise necessary to impart research skills that are essential to students.



IIT Bombay's Director launches a book authored by Ms. Amita Tagare

Prof. Subhasis Chaudhuri, Director, IIT Bombay, launched "Handbook of Hand-holding and Healing" written by Ms. Amita Tagare, formerly in-charge of the Student Wellness Centre, IIT Bombay, on March 9, 2022.

Ms. Tagare has over 30 years of experience in counselling students at the Institute. The handbook is a compilation of Ms. Tagare's journey through various student-related concerns and the formation of a support system that came about through the combined efforts of many functionaries on campus. It serves as a ready handbook for easy implementation by all stakeholders.



IIT Bombay declares in-person exams mandatory after two years

After two years, in-person final exams held in mid-April will be mandatory for all second, third- and fourth-year undergraduate students at IIT Bombay. Second-year postgraduate students will also be required to appear for their exams in person.

Since November 2021, exams at the Institute have been

conducted via a hybrid model – students on campus appeared for their exams in person, while those who resided outside campus were allowed to take their exams online.

The Institute is working towards bringing life back to normal by April 01, 2022. Currently, close to 70% of the 12,000-strong student population are already present on campus.



TECH NUGGETS

Prof. Prasanna Gandhi receives 'Technology Translation Award' from SERB

Prof. Prasanna Gandhi and his team from the Dept. of Mechanical Engineering received the "Technology Translation Award" from The Science and Engineering Research Board (SERB).

The primary mandate of SERB is to support basic research in emerging areas of Science and Engineering.



Prof Sudarshan Kumar from IIT Bombay receives Fellowship at the Combustion Institute

Prof. Sudarshan Kumar, Head of the Department of Aerospace Engineering, is the first Indian to be named a Fellow of The Combustion Institute, PA, USA.

Prof. Sudarshan Kumar received the prestigious fellowship for his contribution to applied research in the field of flameless/mild combustion and the precise determination of laminar burning velocity at high pressures and temperatures.

His research has resulted in crucial breakthroughs and helped develop future combustion systems such as IC engines, gas turbine engines, and rocket engines.

The award recognises Prof. Gandhi and his team's work titled, "Method Apparatus for dynamic motion amplification with frictionless precision guidance" which uses compliant mechanisms to translate in-house developed technology of high-speed 3D microprinting.

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INSTITUTE HIGHLIGHTS

IIT Bombay celebrates its 63rd Foundation Day and honours faculty members and alumni

IIT Bombay celebrated its 63rd Foundation Day on March 10, 2022. The Institute also honoured faculty and alumni members who have contributed significantly to their respective professional fields.

The chief guest for the occasion was Mr. Anil Kakodkar, Chancellor, Homi Bhabha National Institute, and Chairman,

Rajeev Gandhi Science and Technology Commission, and Member, Atomic Energy Commission.

The Institute honoured select alumni members for their achievements in diverse fields, including academics, research, and entrepreneurship.

- The 'Prof. S.C. Bhattacharya Award for Excellence in Research in Pure Sciences' was conferred on Prof. Jugal K. Verma, Department of Mathematics, for his research in investigating the algebraic structures attached to points of algebraic varieties such as curves and surfaces defined by polynomials. These investigations are useful to understand their geometric properties.
- The 'Prof. H.H. Mathur Award for Excellence in Research in Applied Sciences' was conferred on Prof. Jayesh Bellare, Department of Chemical Engineering, for developing cryoelectron microscopy techniques and novel nanostructured materials for biomedical devices, including resorbable implants for regenerative medicine, and establishing their utility by first-in-human clinical trials.

The Institute recognised distinguished alumni who have excelled in their professional fields with the Distinguished Alumnus Awards (DAA). The Institute also conferred the Young Alumni Achiever Awards (YAAA), to young alumni members who have made outstanding contributions in their chosen field of work and are below 40 years of age. These awards were instituted in 2011.

The day also witnessed the handing over of Hostel 5 (on video) which was renovated under the joint initiative called, 'Enhancement of oldest hostels' between the Institute and IIT Bombay Alumni Association.

The event also witnessed the release of a teaser of 'IIT Bombay Gen Zero Women Initiative'. The project was initiated in 2021 to profile the professional and personal journeys of 30 IIT Bombay's women alumni members.

In addition, the event showcased the 'Stay Connected' campaign video initiated by the Dean ACR office. This initiative encourages alumni to update their contact details on a dedicated portal so that they can receive updates about the Institute's latest developments.

IIT Bombay's Foundation Day celebrations were held offline and in the physical presence of the awardees, their family members, Institute functionaries and invited dignitaries, and was transmitted live on social media channels as well.



IIT Bombay inaugurates Hostel 17

IIT Bombay inaugurated a brand-new hostel on its campus on March 27, 2022. The inauguration was attended by Mr. Dharmendra Pradhan, Union Minister of Education.

The new hostel, Hostel 17, stands between Hostel 7 and 8 and is close to Powai Lake, Mumbai. The hostel has separate wings for its male and female students. A separate wing for female students was added to accommodate the increasing number of female students enrolling in IIT Bombay.

CORPORATE COLLABORATION



IIT Bombay collaborates with GETINGE Medical India Private Limited

IIT Bombay signed an MOU with GETINGE Medical to achieve organizational excellence in the field of innovation and technology enhancement through scientific R&D programmes, especially in the fields of Artificial Intelligence and Analytics, medical devices and life sciences.

The objective of the MoU is to promote interaction and share expertise and resources among areas of common interest that will benefit both organizations.

IIT Bombay and GETINGE propose to achieve the following objectives with the collaboration:

1) Carry out R&D activities with respect to medical devices affiliated with GETINGE. These devices are primarily intended for and/or capable of assisting patients with COVID-19.

2) IIT Bombay will actively collaborate with GETINGE towards the development of new medical devices, and/or improve, modernise, and work on technologically advancing existing medical devices.

In line with these stated objectives, the MoU also stipulates the terms and conditions under which GETINGE and IIT Bombay shall engage with each other whilst undertaking various R&D programmes, projects, and activities.

INNOVATIVE PRODUCT AND TECHNOLOGY



Biomedical Engineering and Technology Innovation Centre (BETIC)

Medical devices are critical for healthcare. Local and indigenous development of novel, suitable, reliable, and affordable medical devices change lives and impact the world around us, even as they create new jobs.

Since its inception in 2014 at IIT Bombay, the Biomedical Engineering and Technology Innovation Centre (BETIC) has

built an ecosystem which is essential to develop local medical devices by connecting the key stakeholders in the medical and healthcare industry – government, academia, medical community, industry, investors and

facilitators. Over the past few years, the team has met with several hundred doctors, identified over 400 unmet needs, created 200 novel concepts, and filed 50 patents. They've also developed 20 devices, incubated 15 start-ups, licensed five items to industry, and launched a few products directly into the marketplace.

The following start-up that BETIC supports reflect its core vision – which is to create global success stories of indigenous medical devices by providing the necessary guidance and reinforcement needed to med-tech innovators.



AUTOMATIC SUTURING DEVICE

Inventors' name: Dr. Rupesh Ghyar, Prof. B. Ravi, Dr. Hemant Bhansali

Indian Patent Filing: 1051/MUM/2015 and PCT/IN2016/77.

Technology/ Product: A Low-cost automatic suturing device using standard needles.

Automated suturing devices have greatly simplified the process of suturing during surgery and medical operations and allow less-experienced surgeons to perform suturing and tying knots

safely and efficiently.

While a few of these instruments are available in the market, these products are extremely expensive and cumbersome to use. These devices also require special needles that are difficult to obtain.

The need of the hour is for 'low-cost automatic suturing devices using standard needles'.

The team at BETIC devised a mechanism comprising of a circular groove, wherein a standard needle along with its thread can be placed. Using a needle holder block, the needle is held tight and pushed into the tissue. Once the holder releases the grip on the needle, it returns to its starting position, when it grips the needle tip and pulls it along the circular groove. The holder is then connected to a handle through a cam-and-gear mechanism which allows it to move correctly.

The suturing device at BETIC has undergone several iterations and each time the team has enhanced and improved the device from its previous version. In its latest iteration, the device comprises of about 40 different components.



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SUCCESS STORIES



Students from IIT Bombay win the Prestigious Minus CO2 Challenge

IIT Bombay takes immense pride in their students' successes. Recently, a team comprising of five students – Arpita Chakraborty, Firdush Hussain, Sonal Janagal, M. Tech, 2nd year students (Petroleum Geoscience – Department of Earth Science); Sushmita – M. Tech, 2nd year student (Geo exploration – Department of Earth Science) and Rhythm Shah, PhD, 3rd year student (Department of Earth Science) won the prestigious Minus CO2 challenge organised by the European Association of Geoscientists and Engineers (EAGE). It was their hard work, dedication and perseverance which helped them win this extraordinarily difficult

challenge that has real-life implications for our society and our planet. The team members talk to us about their journey to winning the Minus CO2 challenge.

What is the Minus CO2 challenge organized by the European Association of Geoscientists and Engineers (EAGE)? How did you get to know about it?

Team: EAGE (European Association of Geoscientists and Engineers) was founded in 1951. The EAGE student fund has multiple industry sponsors who organize various student activities globally. The Minus CO2 Challenge is one such prestigious competition where teams from across the globe compete on a project related to energy transition and climate change. Students have the chance to win a grand prize of \notin 2000, as well as get an opportunity to attend a global symposium held annually in Europe.

We came across this project when we took part in the EAGE-Laurie Dake challenge last year. We were delighted to be the 1st runner up out of a total of 21 teams from all over the world. The top 3 finalists were from France, Malaysia, and India.

For those of us who know nothing about the competition - can you explain what the challenge is about?

Team: Well, the Minus CO2 Challenge has a broad spectrum of projects which are all related to issues of climate change and energy transition, as a whole. EAGE started the competition in 2018 and focussed on developing a subsurface hydrocarbon resource with zero net emission to the surface. This was combined with innovative solutions to tackle energy transition problems.

The Minus CO2 Challenge focused on the carbon sequestration potential of Nova Scotia's Scotian Margin. Prospective geoscientists and engineers play an important role in making energy transition a reality through subsurface carbon sequestration.

What brought the five of you together to form this group?

Team: Our group believes in four core values: Togetherness, Resilience, Attitude, and Perfection.

After placing second in LDC-2021, we vowed to win the Minus CO2 Challenge. Maybe we were overconfident when we named our team 'CarboNIL' while participating in the LDC-2021 challenge but we wanted to push ourselves to do better with the Minus CO2 Challenge.

Honestly, we wanted to represent India and IIT Bombay on a global platform. Our team wanted to showcase various state-of-the-art techniques in climate change and energy transition since this is the need of the hour. The world is slowly making an energy switch from conventional energy sources to more renewables and this movement is in a transitional phase. Addressing these issues and creating an effective strategy to reduce CO2 emissions attracted us to the competition.

What were the many challenges you faced while putting together your submission?

Team: The pandemic made the competition extremely challenging. Our virtual connection was insufficient to navigate a project of this size. Also, India was experiencing the 3rd wave of COVID when we returned to campus and continued our work. During this time two of our team members were diagnosed COVID positive. However, we worked in isolation, dealt with tight deadlines, and showcased our work successfully.

What project/model did your group submit to the challenge? Can you describe and explain the potential benefits of your submission to the real world?

Team: We used a comprehensive workflow to achieve an optimum CCUS (Carbon Capture Usage and Storage) strategy for the Scotian region of Eastern Canada.

Our team characterised the prospective sites in terms of basin suitability and geo-mechanical constraints, followed by a techno-economic analysis for reaching an optimum solution for the project. We assessed a mean storage capacity of 215 gigatons and a maximum capacity of 642 gigatons in the subsurface.

We also calculated the storage capacity in 14 stranded and 6 depleted gas fields lying within the area and predicted it to be around 319 million tons. Our strategy involved capturing CO2, transporting it and then injecting it into the reservoirs. The injection strategy involved maintaining and monitoring the site extensively by using 4D seismic and/or soil-water sampling to detect any abnormalities.

We believe our model will be highly reliable for achieving realistic CO2 storage capacities given the massive emission rates of nearly 36 gigatons per year. Carbon sequestration projects can be a realistic solution to CO2 emissions and we believe that additional funding should be allocated to create more of these projects that will be able to store CO2 in the earth's subsurface, thereby adding to NetZero carbon emissions globally.

You must be delighted with your win. How was your overall experience at the competition? Who were your biggest competitors there?

Team: Winning the Minus CO2 Challenge was like a dream come true for us. Since the inception of the challenge, only countries across Europe have won the challenge. Our chances of making the final four were uncertain but we gave it our 100% and wanted to make IIT Bombay and India proud.

The team from Brazil (Federal University of Bahia), who placed second in the challenge, were our fiercest competitors. The other two teams from UAE (Khalifa University) and Norway (University of Stavanger) came up with very novel strategies to tackle carbon sequestration in offshore Nova Scotia, Canada.

Climate change is wreaking havoc in the world and is impacting the oil and gas industry severely. How will your prize-winning model, which will ostensibly create zero-net emissions of CO2, help our world, as well as the oil and gas businesses?

Answer: Firstly, we need to face the energy transition crisis even as we upgrade our inventory. The switch from conventional energy to renewables is in a transitional phase. In this current climate crisis and increase in energy demands due to the rise in population, an effective strategy to reduce CO2 emission is the need of the hour. We believe that by storing CO2 in the subsurface is the best option.

In terms of our model, we were lucky that there was a large amount of data available from the Scotian shelf because there is a proliferation of oil and gas industries in the area. Also, we were able work on innovative solutions for a real-world problem within a specific time frame. The results from our model depicted huge storage potentials available in deep saline aquifers to the order of 100-700 gigatons and stranded/depleted oil and gas fields to the order of 0.2-0.4 gigatons in the subsurface.

The key challenges for us involved geo-mechanical issues with hydrostatic to lithostatic pressure changes, logistics, and, above all, funds/investments for such massive global projects. However, the inherent risks can be minimized by doing a proper risk assessment exercise and also assess the potential for using a subsurface resource. The use of CO2 as enhanced oil recovery in producing fields will add value to the efforts of going NetZero as well as capturing of the emitted CO2 from industries and storing them in depleted oil/gas fields or even within deep saline aquifers will greatly solve the challenge of carbon emissions to the atmosphere.

Your team was mentored by faculty members from IIT Bombay. What role did they play in your winning the prestigious Minus CO2 Challenge?

Answer: We received immense support from faculty members from the Department of Earth Sciences at IIT Bombay. Prof. Sudipta Dasgupta, our faculty advisor for the competition, was our strongest pillar of support. He motivated us throughout the pandemic and encouraged us to think positively. We are grateful to Professor Vikram Vishal, Professor Bharath Shekar, and Ph.D. candidate Somali Roy for their invaluable mentoring and encouragement. We are also very thankful to Professor Santanu Banerjee, the head of the Department of Earth Science, for supporting us throughout this competition. Their pride in our success was the icing on the cake.

What other competitions are you planning to participate in in the future?

Team: Winning this challenge is just the tip of the iceberg for us. Some of the competitions we are looking forward to are the AAPG Imperial Barrel Award, the SPE PetroBowl championship, and participating in the EAGE Laurie Dake and Minus CO2 Challenges in the upcoming years. Although some of our team members will have graduated by then, we will leave behind a legacy of winning that will be continued by the next generation of budding geoscientists and engineers from IIT Bombay.

Congratulations, once again, to the victorious team members. We are sure they will win more such challenges in the future and make IIT Bombay and India proud!

Team Members Quotes





UPCOMING EVENTS

Technocraft Centre for Applied Artificial Intelligence (TCA2I)

The inauguration of the Technocraft Centre for Applied Artificial Intelligence (TCA2I) will be held on April 8, 2022 IIT Bombay.

The Centre was set up by IIT Bombay's alumni members Mr. Sudarshan Kumar Saraf (B.Tech., Dual Degree, Mechanical

Engineering and Manufacturing Engineering, 1970) and Mr. Sharad Kumar Saraf (B.Tech., Electrical

Engineering, 1970) with the aim of leveraging Artificial Intelligence in areas of operations research, data science, and automation in industrial settings. Both alumni members have generously funded the facility through their publicly-listed company, Technocraft Industries India Limited.

Day & Date: Friday, April 8, 2022 Time: 11:00 AM IST Venue: IIT Bombay Campus



Performing Arts Festival 2022

(PAF 2022)

The Performing Arts Festival 2022 (PAF 2022) is the largest intra-college competition held at IIT-Bombay. Students from IIT Bombay organize and perform in the plays during the festival. PAF allows students to explore the unexplored and unleash their creativity by giving them a chance to act, dance, assist with production design and more. Students adapt

popular plays in English and Hindi, produce, direct and perform them on the night of the event.

Day & Date: Sunday, April 10, 2022 Time: 07:00 PM IST Venue: Open Air Theatre, IIT Bombay

STUDENT RESEARCH ARTICLE

Expanding the Electrochemical Stability Window of Aqueous Electrolyte

Name: MD Adil

Department: Energy Science and Engineering

Program: Ph.D.

Significance/Application

An electrolyte is a vital component of rechargeable batteries. Typically, it serves as an electron-insulating and ionconducting medium facilitating the ion-transport mechanism

between the anode and the cathode of the battery. The batteries' electrolyte design needs greater attention because it drastically influences the electrochemical performance of the batteries.

The well-established non-aqueous rechargeable batteries (especially lithium-ion and lead-acid batteries) control most of our energy storage technology, including portable electronic devices and electric vehicles, due to their high energy density and stable calendar life. However, flammable and toxic organic electrolyte applications drastically raise ubiquitous safety, cost, and environmental concerns that aggravate several orders in magnitude among large-scale applications. The recent incidents of the Boeing 787 Dreamliner battery (2013), Samsung Galaxy Note 7 blast (2016), and Tesla Model S explosion (2019) continuously prompt us to consider the prerequisite safety criteria in batteries. Substantial costs are incurred by these flammable electrolyte components, as well as the maintenance of the stringent moisture-free environment for the dangerous combination of flammable and toxic electrolytes.

Consequently, an aqueous electrolyte can serve as a safer alternative to a non-aqueous electrolyte. The non-flammable and non-toxic aqueous electrolyte can alleviate safety concerns and minimize manufacturing and material costs. However, the narrow electrochemical thermodynamic stability window (\sim 1.23 V) of water solvents results in severely compromised energy densities of the aqueous batteries. The battery's energy density (E) is defined as E= capacity * operating voltage. Thus, it is crucial to expand further the aqueous electrolyte's electrochemical stability window for practical applications.

Methodology and Results

We are extensively involved in developing highly safe aqueous-based energy storage battery technology using multivalent ions that can be used as a safe alternative to commercial lead-acid batteries in the near future. The electrochemical cell used for the study voltage expansion experiments was fabricated in our laboratory. A three-electrode cell containing a stainless steel disk (10mm) as anode and cathode separated by a borosilicate separator soaked with supersaturated aqueous electrolyte was used for the experiments.

The electrochemical stability window of the aqueous electrolyte is ascertained by the reductive and oxidative decomposition of the salt, solvent, and additives (if any) in the electrolyte. For better performance of the aqueous batteries, the redox couple potential of both the positive and negative electrodes should lie in the stability window of the aqueous electrolyte. However, in the aqueous electrolyte, water's stable operating potential window is merely 1.23 V, and numbers beyond that results in water hydrolysis. This low operating window of the aqueous electrolyte leads to a lower energy density of the aqueous batteries.

Our group applied the water-in-salt (WIS) concept (supersaturated aqueous electrolyte) that helps us expand the electrochemical stability window of aqueous electrolyte from ~1.23 V to 2.32 V versus standard hydrogen electrode (SHE) using calcium-nitrate based aqueous electrolyte. The WIS electrolyte is defined as when the dissolved salt outnumbers the water molecules both in volume and mass. The WIS electrolyte benefits from the reduced water activity and absence of "free water molecules."

Our experiments observed that the aqueous electrolyte's voltage expansion depends on the electrolyte's molal concentration. The electrochemical stability window of the aqueous electrolyte increases with the increase in salt concentration. The stability window increases from 1 molal to 15 molal concentration of the salt. After 15 molal, the stability window for 15 molal, 17 molal, and 20 molal electrolytes overlapped. This phenomenon indicates the similar "state" of water molecules in the three electrolytes (15,17, and 20 molal), suggesting each water molecule is a part of at least one solvation sheath. A few previous reports also indicate that the aqueous electrolyte without any free water molecules experienced a wide electrochemical stability window because the water molecules hydrated to the metal-ion do not participate in the electrochemical decomposition; thus electrochemical stability window of the aqueous electrolyte increases.

This (15 molal) calcium-nitrate-based aqueous electrolyte possesses high ionic conductivity (44.6 mS cm-1) compared to other existing commercial aqueous-based electrolytes and lithium-based aqueous electrolytes (8.2 mS cm-1). After extensive characterization of our aqueous electrolyte using Raman spectroscopy, we witnessed the extraordinarily high-voltage feature which is mainly ascribed to the fact that almost all the water molecules are strongly coordinated to metal cations (Ca2+) through the Lewis-basic oxygen atoms, resulting in a remarkably decreased chemical activity of water molecules near the two electrodes. Furthermore, no free water molecules are present when the salt concentration is relatively high; all the water molecules are part of the ion solvation sheath.

On the other hand, we proved that there is a transformation from water-separated ion pairs (in the dilute electrolyte) to the contact ion pairs of Ca2+ and NO3– ions in the supersaturated aqueous electrolyte. Also, increased ordered electrolyte structure was attained. This ordered electrolyte structure suppresses water molecules' movement and thereby reduces water activity. Additionally, at ultrahigh concentration, the inner Helmholtz layer is densely populated with the NO3– anions, which helps inhibit the oxygen evolution on the cathode side. When the Ca2+ ion remains coordinated at ultrahigh concentration, the HOMO level of calciumion is lowered due to the lone-pair donation from the water molecule's oxygen atom. As a consequence, the overall oxidation potential is raised.

Finally, using this supersaturated water-in-salt electrolyte (15 molal), a full-cell Ca-ion battery was constructed with a calciated copper hexacyanoferrate (CaxCuHCF) cathode coupled with polyaniline (PANI) as an anode. The battery exhibited outstanding long-term cycling stability with superior rate capability compared to the dilute aqueous electrolyte (1 molal). The full-cell exhibited a specific energy density of 223 Wh/kganode at a current rate of 0.5 A g-1 and even maintained 182 Wh/kganode with a tenfold increase in the current rate (5 A g-1).

Conclusion

This highly reversible, fast ion diffusion aqueous Ca-ion battery chemistry, overcame the slower intercalation kinetic of Ca-ion into the electrode material resulting from the Ca-ion's reduced hydration number and radius.

This novel aqueous Ca-ion battery provides a safe, cost-effective, and environmentally benign solution to largescale energy storage applications where essential criteria such as safety, low cost, and high-rate performance are of utmost importance.



Fig. 1: The summarized material properties of wide band gap material SiC. The expected performance improvement is due to the superior material properties. The device applications.



Fig. 2: The stain-related improvement in a device.



Fig. 3: (a) SiC D-MOSFET cross section for device simulation, showing stress (from process simulation) and region labels. (b) Power D-MOSFET structure from process simulation, showing Si3N4 stressor, and the cutline for stress profile. All dimensions are in μ m.



Fig. 4: (a) XX and YY stress profile for Si D-MOSFET, with 100 nm Si3N4 stressor layer, obtained from process simulation. Nearly uniform 1.2 MPa XX stress is obtained in the channel region. For validation, the inset shows 0.2 GPa stress generated in channel of a planar Si MOS [4]. (b) XX and YY Stress profile obtained from process simulation of SiC D-MOSFET with

100 nm Si3N4 stressor layer. Nearly uniform XX stress of 0.35 GPa is obtained in the channel region.



Fig. 5: D-MOSFET transfer characteristics (ID-Vg) for 300 K, with stress profile from the process simulation shown in Fig. 4. Stress leads to drive current (and OFF current) increase closFig. 5: D-MOSFET transfer characteristics (ID-Vg) for 300 K, with stress profile from the process simulation shown in Fig. 4. Stress leads to drive current (and OFF current) increase close to 10 %. e to 10 %.

NOVELTY

In this work, we have investigated the concept of performance improvement of the power devices by the application of mechanical strain. It has been a staple in a related technology domain, namely Si Complementary-MOS (CMOS) logic devices for computing applications [1]–[3], but has not been investigated with SiC. The stain was applied to the device with a stressor layer (Si3N4) deposited on the device. The exerted stress on the device changes the electronic energy landscape (called the Energy band) of the semiconductor material. These changes improve the speed with which the carrier is transported (called as mobility) in the device. Therefore, the output current improves. The stress-related improvement is summarized in Fig.2.

METHODOLOGIES ADOPTED AND RESULTS

This is a simulation study, and we used a commercial TCAD platform, namely Synopsys, for this study. Both the fabrication process simulator (Sprocess) and device output characteristic simulator (Sdevice) are used for the simulation. We have used experimentally available material parameters for SiC and done calibration to validate the simulation deck before performing desired device simulation. We have designed a novel N-channel SiC power double diffused MOSFET (D-MOSFET) with stressor (Si3N4) layer in the process simulator with experimental elastic modulus values Fig. 3. The resultant stress Fig. 4 is replicated in the device and simulated for transfer characteristics. The result shows improvement in ON-current of close to 10% Fig. 5, through the application of mechanical stress to enhance the electron mobility

CONCLUSION

In this work, we have transferred knowledge of stress engineering in logic CMOS to the power device domain. Process simulations were done to estimate the stress values in the channel of a D-MOSFET device with a Si3N4 stressor layer, wherein the elastic modulus values are drawn from the experimental literature. The SiC-based power MOSFET device simulation shows substantial enhancement in the ON current with stress. As in silicon CMOS, stress engineering can clearly be a knob for mobility enhancement, additive with other researched knobs.

We have filed a patent for this work on May 22, 2020, with patent application number E-11/96/2020/MUM. We have published the work in IEEE, JEDS, DOI: 10.1109/JEDS.2021.3116098. The authors of this work are Suvendu Nayak (IITB-OSU frontier research scholar), Prof Saurabh Lodha, Prof. Swaroop Ganguly of Electrical engineering department, IIT Bombay.

REFERENCES

[1] T. Ghani, M. Armstrong, C. Auth, et al., "A 90nm high volume manufacturing logic technology featuring novel 45nm gate length strained silicon CMOS transistors," in IEEE International Electron Devices Meeting 2003, Dec 2003, pp. 11.6.1–11.6.3.

[2] K Mistry, M Armstrong, C Auth, et al., "Delaying forever: Uniaxial strained silicon transistors in a 90nm CMOS technol ogy," in Digest of Technical Papers. 2004 Symposium on VLSI Technology, 2004. IEEE, 2004, pp. 50–51.

[3] Scott E Thompson, Guangyu Sun, Youn Sung Choi, et al., "Uniaxial-process-induced strained-Si: Extending the CMOS roadmap," IEEE Transactions on Electron Devices, vol. 53, no. 5, pp. 1010–1020, 2006.

[4] Apoorva Ojha, Yogesh S Chauhan, and Nihar R Mohapatra, "A channel stress-profile-based compact model for threshold volt age prediction of uniaxial strained HKMG nMOS transistors," IEEE Journal of the Electron Devices Society, vol. 4, no. 2, pp. 42–49, 2016.