TECH AMBIT

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USING THE STARS FOR GUIDANCE:
IIT-B SATELLITE TEAM INNOVATES

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TRULY PAN IIT!

IIT Kharagpur • IIT Bombay • IIT Delhi • IIT Madras
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THE ATHER TRINITY PART 2 :
WHAT MAKES THEM, THEM

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IIT Tech Ambit *goes Pan IIT*

IIT Tech Ambit's principal mission is to educate and stimulate a discourse on technology, indulging not only in the techniques of scientific research, core ideas behind engineering applications and entrepreneurial innovation but also reflecting on the philosophical aspects of their influence. Our monthly publications explore this mission in around five to ten articles authored and edited comprehensively by student editors.

The technology leaders of the world are increasingly coming from IITs. In their nearly seven-decade long existence, these institutes have grown autonomously with unique administrative and student initiatives. The students' interrelation is currently celebrated through competitions- sports, socio-cultural and technical. However, in our two years of existence, we at Tech Ambit have noticed a lack of student collaboration or value flow from one institute to another.

In this regard, the Pan IIT expansion of Tech Ambit is an unprecedented milestone for IITs. We hold that communication of knowledge of emerging tech through our reporting is the necessary first step to facilitate the exchange of tech-knowledge systems across the ecosystem. The Pan IIT Editorial Board envisions the coming together of IITs not only to review the technological landscape but also to usher in new collaborations between students, professors and alumni which will drive India and IITs higher into the International scene.

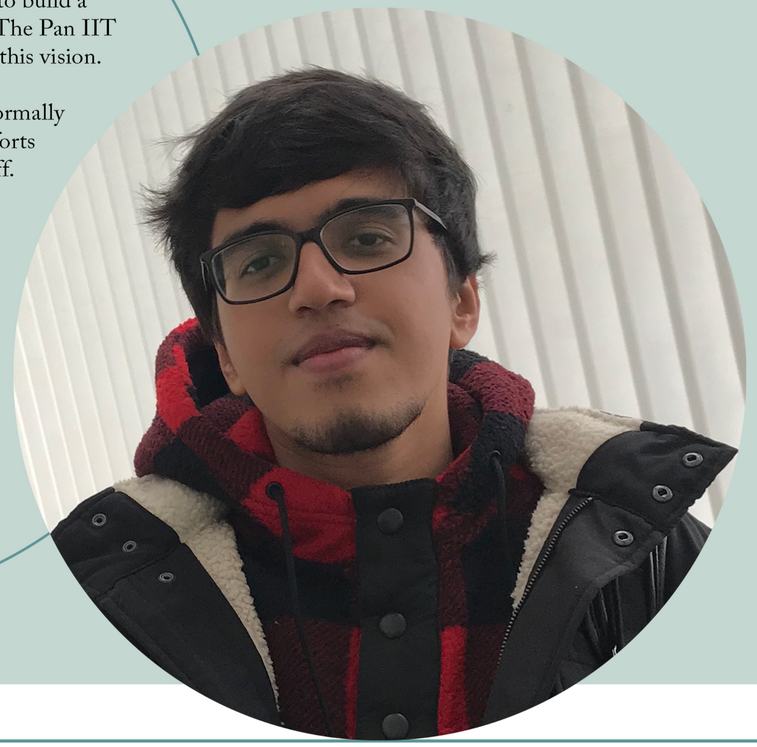
We recognise and plan to widen the scope of this year-long collaboration by bringing in better stories and by providing a community for the entire ecosystem. We happily invite collaborations from other student-run organisations to achieve this aim.

When we started Ambit in 2018, we were just 5 folks but with a big vision - we wanted to build a benchmark tech review body for India. The Pan IIT inclusion is a big step towards realizing this vision.

I remember how we began - 5 of us informally meeting in a library and pouring our efforts into something that might never take off. From there, we've grown into a team of 35+ members across 7+ IITs, raised funding and published 60+ articles! A huge shout out to Suraj and team whose combined efforts have made all of this happen. Keep going and keep growing guys!

Utkarsh Sinha

Founder & Advisor



I would like to personally thank Mukund Khandelwal (IIT Madras), Amogh Gawaskar and Suman Mondal (Chief Editors Insight, IIT Bombay), Atharva Shukla and Sudhang Varshney (Chief Editors - Watch Out, IIT Roorkee) and Pratyush Pandey (Chief Editor- Board of Student Publication, IIT Delhi) for sharing the vision of this collaboration and aiding in the smooth expansion. My sincerest thanks to Prof. Suman Chakraborty (Dean, Sponsored Research and Industrial Consultancy) and Prof Abhijeet Chandra (VGSOM, IIT Kharagpur) for their timely guidance and support.

Lastly, I must acknowledge my senior comrade and friend Utkarsh Sinha, for reaching out to me so long ago with an offer to write for a new tech review magazine. How far we've come! I hope this news brings you great satisfaction. IIT Tech Ambit is here to stay!

Tech Ambit has grown rather uniquely to adopt its own internal work culture, undeterred by lack of physical infrastructure- we have always worked completely online! We realise that technology is an enabler but also that its good design that grants equitable access to all. Magazines essentially being a visual medium, have shown us the power of design to strengthen our communication. We hope you appreciate the new design language we have adopted from this issue onwards.

Suraj Iyyengar

Co-Founder & President
PAN IIT Editorial Board

About the Issue

From our very inception, IIT Tech Ambit has always dared to dream a little bigger. To be a vehicle of science and tech communication; a platform of collaboration of ideas; to speak to people from all walks of life - on an India wide scale.

For the past few months, we have been furiously working behind the scenes towards the realisation of this goal. And to see that begin to bear fruit, is spectacular and truly humbling.

IIT Tech Ambit is proud to announce we are now Pan-IIT.

Starting from this issue, our stories will contain work by editors from the other IITs, in addition to our first editorial team in Kharagpur.

I'm immensely grateful to the 3 new editors who have enthusiastically taken up the challenge. Their sincerity, energy and willingness to take a risk has been incredible to witness. We're building up this project, and our message to anyone with a buzzing passion for science and an itch to write - you are welcome here!

We thank all our readers for being there to support us at each step. To many more milestones to come!

Pranav Krishnan
Editorial Head

To reach out with feedback, collaborations, submissions, or just to chat with us about the tech we love to talk about! Email connect@iit-techambit.in

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Using the Stars for Guidance : IIT-B Student Satellite Team innovates

The story of Satellite Team, IIT Bombay - their achievements till date, followed by the development of their latest innovation: STADS.

Written by **ABIR MEHTA**
Designed by **HAVEEN HRITHIC**

The Student Satellite Program is a landmark project taken up by IIT Bombay students with the vision to make it a respected Centre of Excellence in Satellite and Space Technology in the world. An interdisciplinary team of 50+ students from the institute are engaged in projects ranging from the design of space systems to the development of payloads.

Their first satellite under this program was launched on board the PSLV (Polar Satellite Launch Vehicle) C-35 on 26th September 2016. This satellite, called Pratham, could fit within the dimensions 30.5cm X 33.5 cm X 46.6cm and weighed only 10.15 Kg.

The mission statement for Pratham involved measuring the total electron count (TEC) of the ionosphere which is used to correct ionospheric errors for differential GPS.

The mission also aimed at spreading knowledge about satellite systems across India by transmitting TEC data so that it could be detected by any university having an above ground station.

Having successfully launched Pratham (the mission was 90% successful), the IIT Bombay Satellite Team started working on improvements to some of the systems used in their first satellite, so that they could have a second and more spectacular launch. This new satellite was named Advitiy, meaning second to none.

For now, the team has put Advitiy on hold and plan to perform Technology Demonstrations on the Stage 4 Orbital Platform of ISRO's PLSV. One of the most ambitious improvements proposed, not just Advitiy but for future CubeSat missions in general, was developing a Star Tracker Based Attitude Determination System (STADS).

Attitude refers to the orientation of the satellite with respect to some defined reference frame (in this case, the frame of the earth). Many subsystems in a satellite, which need to be pointed in the correct direction to function, such as communication antenna, docking systems, spectrometers, electron sensors etc. depend on its attitude. This makes attitude determination one of the most crucial subsystems in a satellite.

"Star Tracker based Attitude Determination System is one of the most accurate ways to estimate a spacecraft's orientation in space. Its application in CubeSats has seen a decent increase in recent times", **explained Sanskriti, a Project Manager of the IITB Student Satellite team.**

It is superior to the sun sensor - magnetometer combination used in Pratham, which uses the direction of the earth's magnetic field and displacement vector with respect to the sun for attitude determination.

The reasons are simple, firstly, these can't be used for deep space missions due to the absence of magnetic fields.

Secondly, since STADS uses numerous stars to evaluate attitude, it has a greater number of data points as compared to sun sensor - magnetometer combination allowing it to achieve greater accuracy.

How exactly does STADS work?

The way STADS works is that it compares images of stars taken from the satellite and those taken from the earth frame (or ground frame) to estimate the orientation of the satellite. The idea is to make this comparison four times in a second in order to keep constant track of the attitude of the satellite.

The system first uses a CMOS camera to take black and white images of its surroundings. Due to high intensity bright sources in the path of the camera, a baffle system is used to prevent stray light from entering the optical processing system.The stars in these images are two-dimensional shapes on a black background. Feature extraction is used on these images to obtain the spatial coordinates of the stars by detecting the "bright spots" in the images.

These two-dimensional spots are then converted into point objects using a process called 'centroiding'.

Now, unit vectors can be drawn in the direction of these stars (now converted into dots on a black background), this helps in determining the absolute orientation of the satellite. Since the satellite is not aligned with the ground frame (that is the frame of the earth), the unit vectors thus drawn will not be the same as the unit vectors in the star catalog (chart which gives information about the vector direction of 4000-5000 stars from earth frame).This set of unit vectors are then compared with those in the star catalog. Estimation algorithms are then used to find the rotation vector along which the obtained set of vectors should be rotated so that they can best match the ones in the star catalog.

The rotation vector by which these unit vectors were rotated is the same as the rotation vector between the orientations of the satellite and the earth frame, or the attitude of the satellite.

How did they plan to progress?

It is important to note that STADS is a relatively new concept in India and has not been employed in any Indian student satellite yet.

As a result, the team had to research through a multitude of papers, datasheets, and catalogs before considering such a task. Hours and hours were spent mulling over these papers before they were able to understand what the exact requirements of such a system would be. A thorough study of other star-based tracking systems yielded a set of specifications that they would try to implement in their own model, STADS. The team has also been in touch with the satellite team at Tsinghua University, Beijing which has worked on star-tracker based systems in the past.

PSLV: A medium lift launch system. Launch site: Sriharikota, an island in the Bay of Bengal

The satellite team at IIT Bombay performs rigorous testing on a model before manufacturing it. The testing is usually done in four steps:

1. First, a simple MATLAB model of the overall model is tested to get a general idea of the computational and hardware requirements of the system. This step is known as model-in-loop testing.

2. In the second step, software-in-loop testing, each subpart (in this case, image capturing, image processing, and estimation) of the model is tested on specialized simulation platforms (usually C programmable) to ensure that they perform well individually.

3. Since the team is planning to use a combination of FPGAs (array of programmable logic gates) and microprocessors to perform the required computation on the satellite, it is important to run simulations on them to check how efficiently the required calculations are executed. This third step is called processor-in-loop testing.

4. The final step, hardware-in-loop testing, involves testing the system on the pieces of hardware that will be used on the satellite.

On June 15th, 2019, ISRO began accepting proposals to facilitate the launch of payloads on the 4th stage orbital platform of the PSLV. This part of the PSLV usually gets detached from the main spacecraft and adds to space debris, however payloads such as CubeSats can be attached to this 4th stage and be used to carry out in-orbit experiments and calculations.

This provides a great platform for testing satellite systems and at the same time ensures that parts of the PSLV do not go to waste. The Satellite team, IIT Bombay intends to test the STADS system they developed in real spaceflight on this platform.

What were the difficulties faced by the team?

At present, the team is in the designing phase and still has a lot of work left to perfect their system. So far one of their biggest difficulties has been that STADS requires a lot of computing power to execute.

As a result, the required onboard processing power of the satellite is really high. To maximize the computational power of the satellite, they decided to use FPGAs (field-programmable gate arrays). These are reconfigurable integrated circuits that use arrays of programmable logic blocks to perform computation.

They are far more energy-efficient than common processors such as CPUs or GPUs and are preferred in cases where quick computations with low latency are required. Thus, they are ideal for applications such as STADS because it needs to perform a series of complex calculations in a span of four seconds.

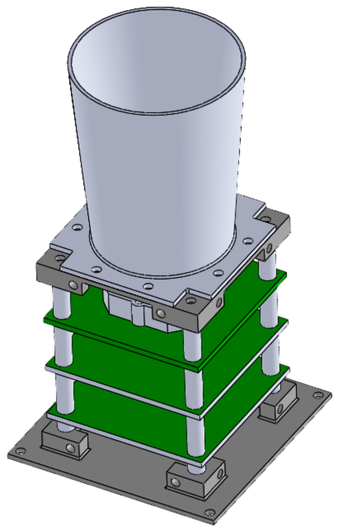
The problem with FPGAs is that they are extremely tricky to program and the team does not have any experience working with this technology. Finding out which FPGA to use and how to make a PCB (Printed circuit board) for it are both complex tasks which they are working on.

Some of the other difficulties are trying to find an optimal 'star matching' algorithm which identifies which stars the camera is currently looking at.

Designing an optical system consisting of a lens and baffle (used to block out unwanted light reaching the image) to fit the volume constraints of a CubeSat (needs to be 10cm X 10cm X 10cm cube) is another challenge.

All these difficulties are compounded by the fact that they are among the first in India to try developing a star-based tracker system. As a result, it is hard to find solutions to these problems because of the lack of resources dealing with specific issues faced by STADS designers.

Before the ongoing pandemic struck India, the team had designed a timeline that would ensure the completion of a flight-ready model by 2021. Presently, however, it seems that work will be delayed due to the lockdown.



An internal CAD model of the proposed STADS system. The cylinder on top is the baffle and the green squares represent the PCBs.

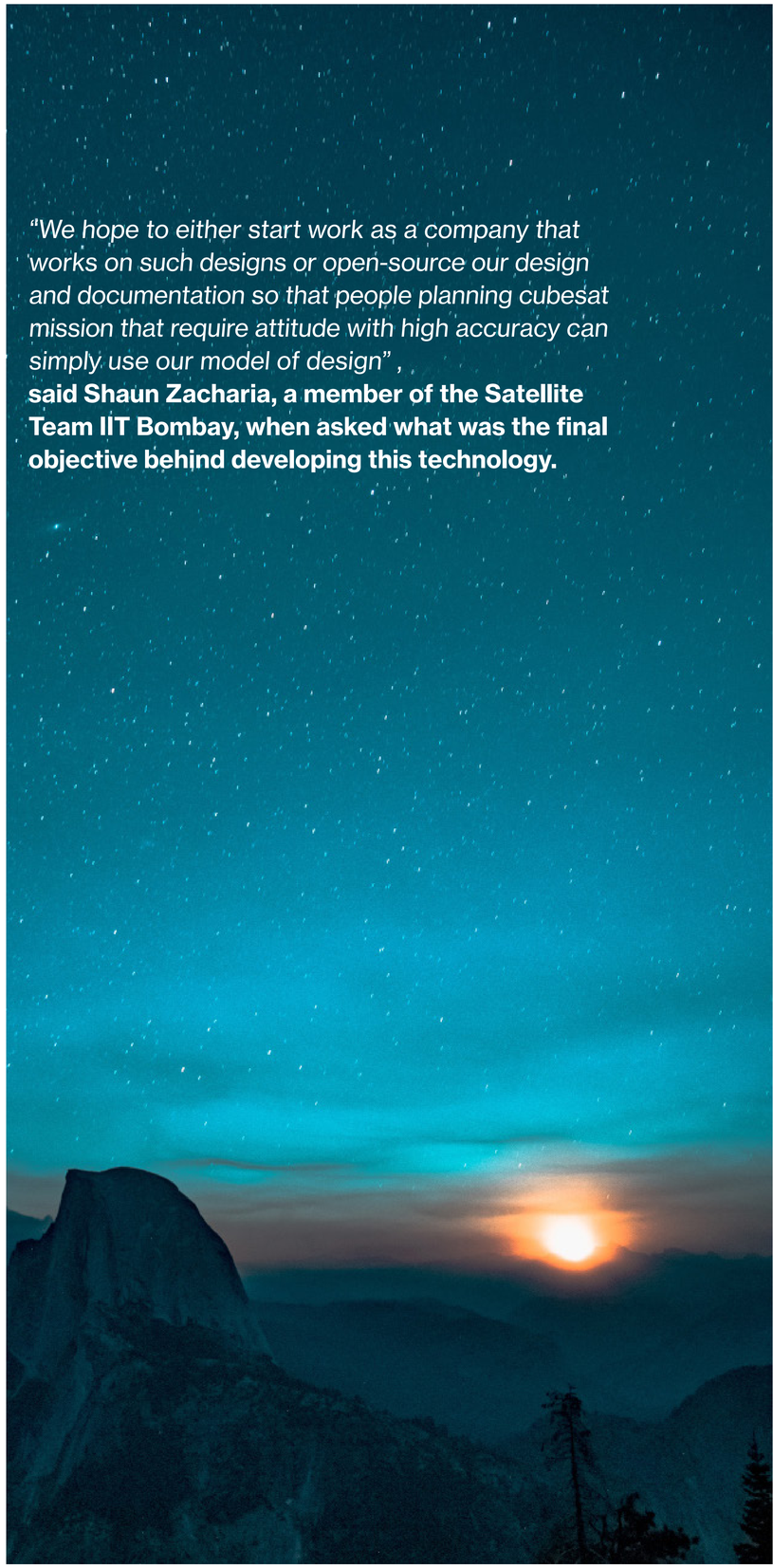
It is much harder to coordinate between interdependent subsystems and assert decisions given that the only way to communicate is virtual. Further, since they cannot manufacture parts, purchase the required instruments and sensors, the task of validating the framework has become a lot more complicated. Rather than performing tests on hardware, they now have to depend on research papers to confirm their results.

In spite of the lockdown, Satellite Team IIT Bombay has continued working and are hoping to complete the first iteration of their model-in-loop testing phase by the mid-July.

What is the end goal?

Given that STADS has the potential to improve the accuracy of attitude determination for CubeSats, the open sourcing of this technology would make it easier for student teams all over India to design better satellites. A more accurate attitude determination system also implies improved performance of dependent subsystems of the satellite. Thus, through their efforts, the Satellite Team IIT Bombay is trying to make space exploration more accessible to the student community.

"We hope to either start work as a company that works on such designs or open-source our design and documentation so that people planning cubesat mission that require attitude with high accuracy can simply use our model of design" ,
said Shaun Zacharia, a member of the Satellite Team IIT Bombay, when asked what was the final objective behind developing this technology.



The Ather Trinity Part 2 - What makes them, them

Ather Energy has started out in making an entire ecosystem that defines the product they're selling, and gives the consumer the fancies of an Electric Vehicle future - all of this while sticking to their vision of arriving at the best product through rigorous in house engineering techniques.

Written by **ARCHI BANERJEE**
Designed by **HAVEEN HRITHIC**

India's electric vehicle market is still at its infancy. There are numerous challenges : one of them being the obsolescence in the manufacturing outlooks of incumbent players (For a more in depth understanding, read the first article in this series, if you haven't.) As argued previously, Ather Energy seems to provide an unique solution to this problem by rethinking the vehicle integration process. Their intelligent electric scooters are designed to give a consumer the futuristic experience of riding an electric vehicle.

Before we delve deeper into what Ather does that really makes them stand out, let me formally introduce this tech intensive startup.

"When we started, we said that we will only build batteries for existing vehicles because there is no Lithium-ion battery (pack in the market). We will build it and sell them. We thought that batteries were the only thing wrong with electric vehicles," says Swapnil Jain. But later realisation hit that "almost everything is wrong in existing electric vehicles. As a startup, we have to build something that's redefining the segment"

Ather Energy - a quick peek into their journey so far:

The journey of Ather began in October 2013 at the Indian Institute of Technology Madras Research Park. Tarun Mehta and co-founder Swapnil Jain, both IIT-M alumni (B.Tech & M.Tech batch of 2012 in engineering design), had set out to build India's first smart electric scooter. The idea got its fuel from a research on swappable batteries model, on which they were working as a project in their final year of graduation course.

For the founders of Swapnil and Tarun, the thought of redefining electric vehicles led them to the invention of an intelligent scooter powered by IoT and sophisticated algorithms for data collection and battery pack management, that would enable people to navigate on the roads. Driving on roads can be tricky, with roads cratered with potholes, streets with no names, chronic traffic congestion, confusing city layouts, and free-for-all driving.

Swapnil and Tarun had the vision to tackle such problems with an electric scooter that constantly evolves based on road-data, driving habits, and vehicle performance.

Ather Energy was born with a vision to solve the problem of energy storage and supply in an electric vehicle. It is building a futuristic electric scooter which aims to go head-to-head with the best e-scooters in the market.

They believe that the vehicles of the future will be smart, connected and clean and they want to accelerate the adoption of these vehicles.

Ather Energy and its Vertical Integration charm:

One of the co-founders, Tarun Mehta, pointed out in a video that the problem with the EV industry in India is that the entrenched players are following the horizontal model of vehicle integration, whereas any industry at its start usually goes forward with vertical integration.

The Electric vehicle has several hardware and software components - battery cells, BMS (Battery Management System) and the electric motor - to name a few. Under the horizontal model of integration, the manufacturer gets the individual components from different vendors and then tasks themselves with just vehicular assembly.

This poses a problem, as the vendors themselves do not have the specific elements that would be best suited for a particular electric vehicle (due to the industry's relative low age) and end up selling the substandard for an absurd price. This keeps the initial acquisition cost very high and the product does not achieve reasonable market prices.

Ather Energy tackled this problem just like Apple does - they integrated their production vertically. Unlike other electric vehicle companies, the company itself owns and controls its process, the suppliers, distributions, the whole supply chain.

They brought all of the technology in house and built everything from scratch (apart from the very basic ingredients - like the Li ion battery cell, which has to be imported) and in the process, reduced initial acquisition cost, created better prototypes and products, and also allowed themselves to bring unorthodox features to their product - for example: a Battery Management System (AKA the brain of the vehicle) built entirely by the people at Ather, that helps monitor all the cells, voltage, current, load, and temperature.

It helps track the performance of the battery pack on a daily basis, and it has inbuilt algorithms that learn continuously about the usage and performance of its battery packs.

The software of the BMS can be modified to improve battery life and efficiency by algorithms that learn from one's driving style and battery usage trends. Other examples include building their own chassis, suspensions, lithium-ion battery packs, battery management systems and bodywork themselves, and self-reliance for collecting several real -time data types on the scooters - throttle, RPM, brake, horn, accelerations, orientations, and location

The vertical integration model isn't just an optimal choice for building a better electric vehicle, it is also an integral part of Ather's vision and dedication towards building a startup based on rigorous engineering and innovation. This vision doesn't restrict itself into just supply chain management, but also makes itself apparent in Ather's other structural changes - one of them being their 'Design Space' approach to Vehicle Development.

The Vehicle Development Process that Ather changed:

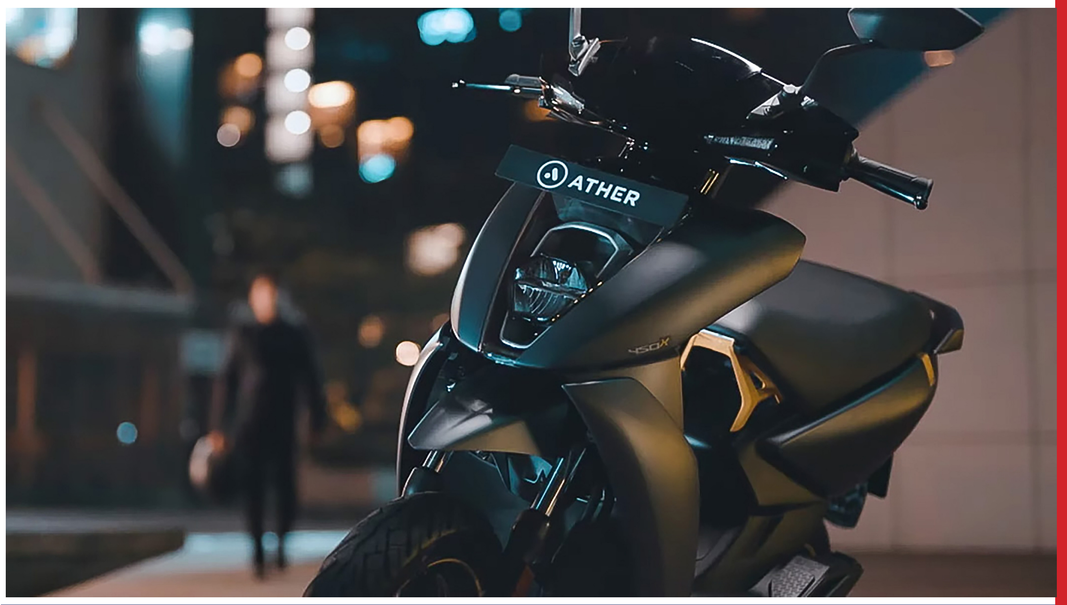
Typical processes of any vehicle development start with materialistic thoughts to form sketches, drawings, renderings and write-ups which form the foundation for the development of the product. Then the development process is distributed among different engineering teams. On the mechanical side, the design team and CAE team work in conjunction. The work starts with creating a basic CAD (Computer Aided Design) of the vehicle which is then analysed by the CAE (Computer Aided Engineering) team. After the feedback given by the CAE team, the part returns to the design team. This loop goes on until a satisfactory result is produced that fits into all the parameters.

Ather energy was not ready to continue this legacy approach. They observed some flaws in this, such as:

* The number of iterations is huge and the time taken for a final design is considerably high.
* There is no direct correlation of the design and simulation i.e., the design engineer has little understanding of the simulation and what are the parameters on which the part is being tested.

They believe that the standard vehicle development timelines require a tighter interaction between the design and analysis team. They believe it is important that broader decisions like "what does the product stand for?" and "how it will feel, look and behave?" are made known to the entire team. Whether it be the mechanical team or the android developer, the designer or the power electronics team - it's ensured that every team member imbibes these ideas, so that every component will follow a common theme leading to a naturally focused product development.

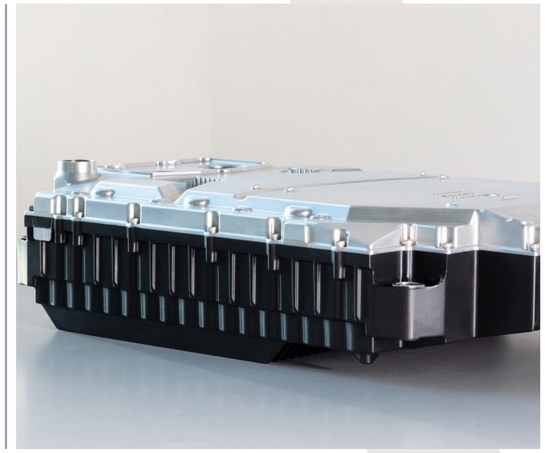
Instead of performing several iterations between design and simulation departments, unlike the typical process of vehicle designing,



Ather 450X : upgraded version of the electric scooter, the Ather 450X in Delhi, Mumbai, Pune and Hyderabad, apart from Bengaluru and Chennai.

at Ather, they start with engineering constraints on the first step and then build a 'Design Space'. As they describe it, a design space is a collection of engineering and manufacturing constraints which define hard points or constraints for the product and its bulk.

'Topology optimization', a mathematical method, is then performed on this design space which gives an approximate design. It optimizes material layout within a given design space, for a given set of loads, boundary conditions and constraints with the goal of maximizing the performance of the system. The program here analyses a component by its physical parameters and by keeping the constraints at the back end finds the places where the material is required and trims all the excess material, thus giving the most optimized part that can be designed within the constrained design space.



A Lithium ion battery pack : have a high energy density that can deliver a high amount of power from a small structure.

This is then given to the design team which works on refining the rough layout into something closer to the final product's required aesthetics and weight targets.

The introduction of this new approach to design has led to the more involved and interconnected design process where the design engineer and simulation engineer bridge the gap of understanding the product in all aspects be it aesthetics, packaging, light-weighting, durability.

Case in point: Ather's in house BMS and Battery pack

Designing their own battery packs with new modifications is one of Ather Energy's defining characteristics. Battery packs are responsible for keeping the cell in safe operating conditions. Li-ion cells, the current choice for powering an electric vehicle, have a high energy density that can deliver a high amount of power from a small structure. Also with minor alterations in the electrode makeup, it can be made to deliver exceptionally high power densities.

Despite its overall advantages, lithium -ion has its drawbacks. It is fragile and requires a protection circuit to maintain safe operation. There is a safe operating area recommended for any lithium-ion cell; this is usually the temperature range, voltage, and maximum charge/discharge current. Taken outside these limits, the cell can become unstable.

Cell Cyclers at Ather's Cell Testing Facility

To get maximum output from the Li-ion batteries, it is necessary to minimize the degradation and increase the cycle life of the battery while getting the sufficient aggregate power required from a given number of batteries. This is where the Battery Management System(BMS) fits in and plays a very critical role in managing the battery pack and enabling it to work in optimum conditions. A Battery Management System (BMS) is an electronic system that manages a rechargeable battery, by protecting the battery from operating outside its safe operating area, monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and balancing it.

Designing an in-house BMS not only puts the limitations on the drawbacks of Li-ion batteries but also offers more options. To extend the battery life without compromising on performance, at Ather they built an arsenal of 500+ cell cyclers housed in chambers set at different temperatures, and rigorously tested cells under a gamut of conditions.

The know-how gained from internal cell tests led to the development of an intelligent BMS in the form of a bunch of algorithms. Multiple thermal sensors integrated with the Ather's BMS enables the rider to get extensive heat data inside. Above all, the bigger advantage is that it aids in identifying and integrating individual components. This makes features like Over the Air updates possible. The board also includes a separate controller for data analysis and sharing them with the dashboard and cloud. The main functions of Ather's BMS includes controlling power modulation and charge optimization algorithms to ensure that the battery operates within the optimal voltage and temperature levels with minimum impact on charging time and efficiency. The BMS processes information from a multitude of sensors onboard to estimate and keep track of the battery's health.

The in house BMS is just one of the many examples of Ather rethinking the electric scooter. There are several more:

The Smart Dashboard : one of the many examples of Ather rethinking the electric scooter.

A Smart Dashboard

The Ather scooters contain a 7-inch smart display at the front which provides the rider facilities of on-screen navigation and integrates the cloud-based data that helps to personalize the consumer ride experience. This intuitive dashboard in front is equipped with 1.3 GHz Snapdragon Processor, Bluetooth connectivity and Google Maps.

With in-built maps, Ather removed the hassle of stopping over and checking mobile phones. It also consists of a navigation module which allows the users to opt for preset routes and plan the journey according to their wish. The maps also show nearby charging points and alternative routes for dodging traffic. Ather also built their own user interface(UI) on the top of an embedded platform which provides very clear and direct communication between the rider and the vehicle.

The software engineers at Ather claim it to be a very different architecture than a typical mobile or web app because it directly interacts with the vehicle and changes things like ride mode and peripherals. Every single piece of peripheral on the vehicle is controlled by software — light, horn, key, speakers. It's what powers an auto to turn off the indicators.

The telematics hub makes all the communications from and to the vehicle possible. This ensures that the vehicle is constantly connected to the Ather server and monitored by it. Constantly communicating vehicle data like speed, riding mode, temperature, braking and other parameters with the server help to analyze and improve the ride experience with over-the-air updates.

The hub also enables host features like communicating alerts on low pressure in tires, low charge, unexpected overheating, overexposure to sunlight and much more. There are 46 sensors on the vehicle — each of these sensors talks to the cloud to provide the rider with real-time information. With a focus on end-to-end customer experience and building smart transportation for the future, Ather embraces the cloud to accelerate the process of development, production, testing, and launch of their cloud-based connected scooters.

Real-Time Data Gathering with MESSI

Making Every Scooter Smart and Intelligent (MESSI) was developed to gather more data than what they gather from prototypes and testing teams. MESSI can be plugged and used comfortably with almost all types of existing scooters.

With MESSI, essentially a Data Acquisition System, Several data types on the scooters are collected- Throttle, RPM, brake, horn, accelerations, orientations, and location. MESSI is now capable of collecting additional data — on temperature, weather conditions, riding with a pillion, and brake pressure. Also, a GSM connection allows real-time data monitoring for a quick and accurate analysis. The drive cycle data that are gathered from MESSI is valuable: it gives insights into how people actually use their vehicles on the road. MESSI helps to make decisions based on real data acquired in real driving conditions.

Real-Time Data Gathering with MESSI : Versions 1 and 2 of MESSI

An Ather Grid charging point

Ather Space and Ather Grid:

Ather has also set its own charging network at different locations across Bangalore and Chennai. These DC-fast-charging stations called Ather Grid use Ather's proprietary charging method and connector to charge the Ather scooters at a rate of 1 km/min.

The Ather Grid business is stand-alone – structured as a different company. The charging points are also equipped with a 3-pin socket to supply AC power to other electric vehicles that do not use Ather's connector. Unlike most auto manufacturers in India, Ather Energy owns and operates its own Experience Centers.

The company claims that this helps in maintaining the end-to-end customer experience. These Experience centers, dubbed as Ather Spaces, aim primarily at providing customers with the insights of the Ather bikes developed by them. The Ather Spaces are equipped with the facilities of customer supports that provide them with first-hand experiences and test drives. All the information and details related to the manufacturing of Ather bikes are delivered to their customers from their experience centers.

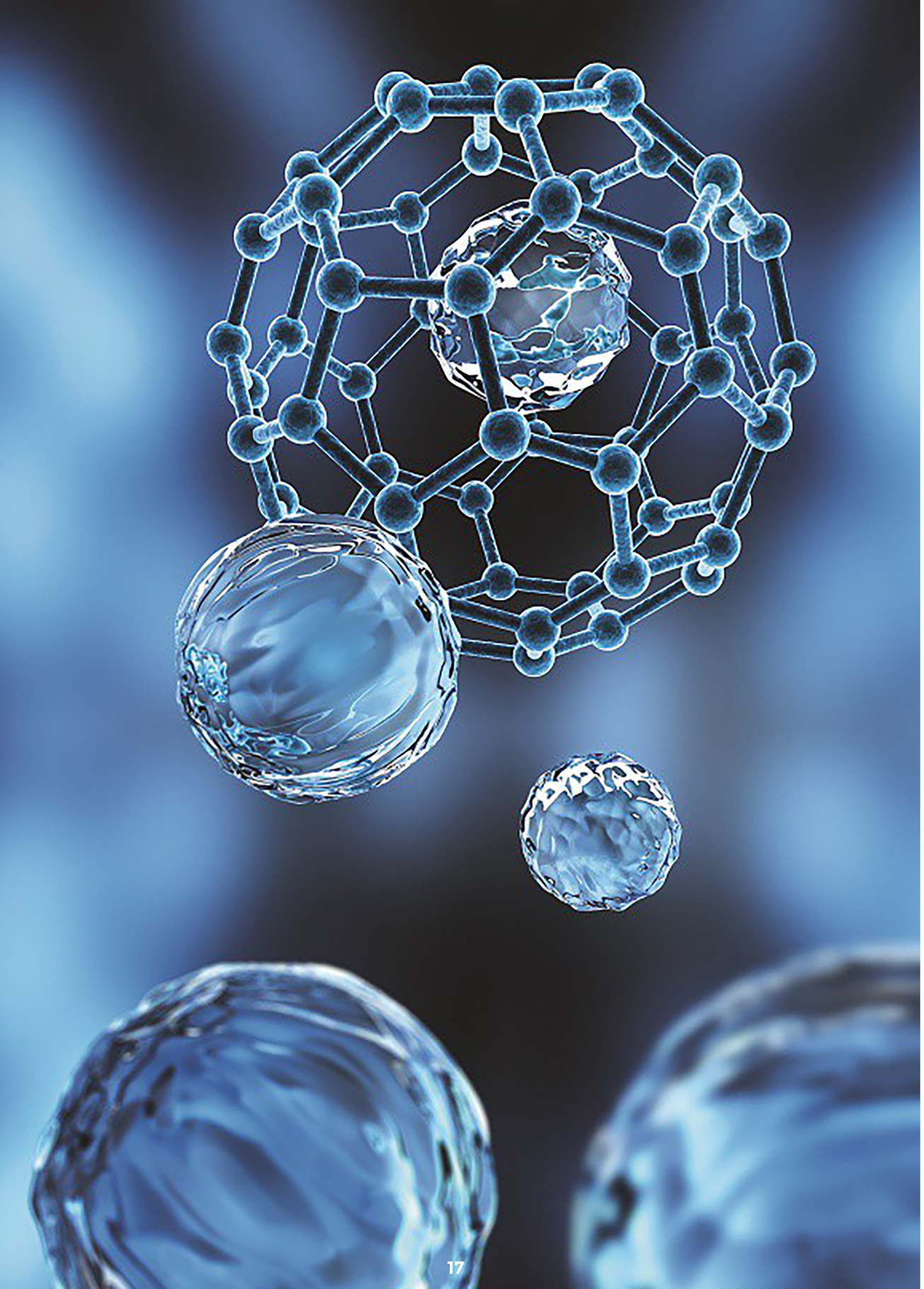
What does all this amount to

As said previously, the USP of Ather Energy is not just in restructuring and fixing the vehicle development and supply chain management processes.

Ather Energy has started out in making an entire ecosystem - with their cloud services, over-the-air updates, on the go charging infrastructure; that not only defines the product they're selling, but also en-wraps the consumer in the fancies of an Electric Vehicle future, apart from personal economy and ecological benefits. And they're doing this while sticking to their vision of creating a startup that hinges on the philosophy of arriving at the best product through rigorous engineering techniques carried out by solely themselves.

The rise of Ather Energy, along with a host of other startups in the Electric Vehicle Scenario in India is emblematic of an epochal shift in the automobile industry.

This change is being driven by a thirst for innovation and well rounded engineering, and by the realization that the Electric Vehicle is a product like the smartphone which will redefine our lives, our perception of ourselves and our interactions with technology in a futuristic world.



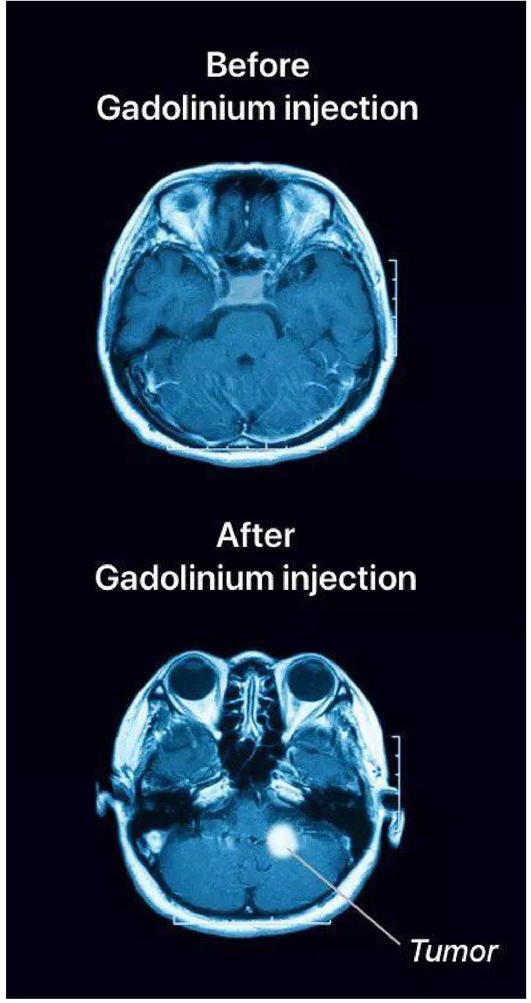
From pepper to particle: Revolutionising Nanotechnology

Nanoparticles synthesized with the use of a plant extract discovered to have fascinating applications in the biomedical industry

Written by **APARNA NARAYANAN**
Designed by **HAVEEN HRITHIC**

Nanoparticles are exactly what they sound like, extremely small particles. To be specific, particles having a diameter in the range of 1 to 100 nanometers. These nifty little things have seen a sudden boom in recent times because of the unique properties they exhibit. Just like classical and quantum mechanics predict very different kinds of behavior, the properties of many conventional materials change when they are made from nanoparticles. The reason for this is very simple: due to their extremely small size, nanoparticles tend to have a large surface area to volume ratio and they also show certain quantum effects. Consequently, they obtain various physio-chemical properties depending on their composition and are also favored for the specificity and reactivity they offer.

Of the plethora of nanoparticles out there, one stood out for the Ph.D. scholar from IIT Indore, Mr. Prashant Kharey. As a researcher in the application of nanomaterials in biotechnology, superparamagnetic iron oxide nanoparticles (SPIONs) showed tremendous promise. Iron oxide nanoparticles are already a widely researched topic because their unique magnetic properties lead to wide-ranging applications. This includes cell sensing and imaging, targeted drug delivery, and also as a contrast agent for MRI. This is essentially due to the magnetic nature iron oxide possesses, making it suitable for most optical imaging techniques and applications that rely on magnetism for identification.



Contrast MRI : Comparison of MRI before and after the use of Gadolinium-based contrast dye.

For example, contrast MRI is performed using a dye that can be injected into the bloodstream to selectively get absorbed into certain tissues, and this shows up on the imaging because of magnetic compounds contained in the dye. The usage of a contrast dye makes the image clearer and also aids in highlighting soft tissues and moving fluids like blood, which are normally not visible on a standard MRI.

Clearly, these are very important biomedical applications, but this brings into question the safety of this mechanism. Conventionally, a contrast MRI leaves the person with side effects like nausea, dizziness, headaches, and numbness. This is attributed to the toxicity of the agents used in the contrast dye.

What did they do differently

This brings us to one of the biggest hurdles in the usage of chemically synthesized nanoparticles and reagents for biomedical applications.

Currently, most commercial techniques for the fabrication of nanoparticles involve chemical solvents which lead to toxicity and non-biodegradability. They also require heavy machinery and involve energy and time-consuming processes which make them economically infeasible.

The researchers at IIT Indore managed to make a breakthrough in addressing this problem by coming up with green synthesis.

Simply put, this refers to the synthesis of eco-friendly and cost-effective nanoparticles that are biocompatible, so they do not cause any toxicity in the body. It was another feather in their cap when they discovered that the compound they synthesized in this manner exhibited NIR absorption, giving it incredible photothermal applications in cancer treatment.

The method

How exactly did they manage to synthesize a nanoparticle bypassing the dangers it posed to the biological system conventionally?

By using a green source of course. Myrtle pepper, or in more formal jargon, *Pimenta dioica*, is an aromatic plant commonly known as the source of allspice, which is derived from its unripe berry. This tropical tree has been commonly used in the perfume and spice industries and even hypothesized to contain medicinal properties. Here, however, this plant has been used a bit differently.

The extract from the leaves of the *Pimenta dioica* function both as a reducing agent and a stabilizer in the green synthesis of SPIONs. This is because of the eugenol (an organic medicinal compound commonly found in certain classes of plants) present abundantly in the leaves that serves the purpose of typical chemical solvents without being as harmful or toxic. The eugenol also leads to the E-capping or eugenate capping found on the iron oxide nanoparticles after synthesis.

So what is capping and how does it affect the nanoparticle? The surface chemistry of the nanoparticle basically influences how it interacts with other substances as well as prevents the particles from agglomerating.

In the context of a biological system, this means the solubility, stability, and biocompatibility of the particle all depend on what is on its surface.

Biocompatibility can be in terms of how well the particle can be absorbed into a cell for further action, the ease with which the nanoparticle can circulate and be removed from our body, and whether it can be broken down without leaving behind traces of any harmful residue. By using a plant having medicinal properties already, the product synthesized is naturally biocompatible with efficacy for therapeutics.

Now we have a nanoparticle with a proclivity for magnetic imaging and it's bio-proofed. But that's not all it can do. These E-capped SPIONs were also able to absorb light in the near-infrared range (800-2500 nanometers).

The significance of this specific absorption is its application in photothermal therapy. As the name indicates, photothermal therapy refers to heat generation being activated by light. NIR light is generally used for these processes because its absorption and scattering in the body are minimal, so it reaches the target site with negligible losses. When this light reaches the target site, the NIR absorbing compounds we place there absorb this light and heat the surrounding area to a limited range. This process is the basis of hyperthermia, a photothermal therapy technique where the temperature of the target cancer cells is raised to 42 degrees Celsius and maintained for a short duration, thereby destroying them.

Clearly, locating the NIR compounds accurately and optimizing the heat generation is important to perform this treatment effectively. The E-capped SPIONs cover all these bases because they can be magnetically located and clustered at the site of a tumor, and due to the E-capping, they show better NIR absorption than most magnetic nanoparticles which also hold the risk of unknown toxicity. Photothermal nature can also be used as a mechanism for targeted drug delivery, in which the heat generated from exposure to NIR light releases a drug attached to the nanoparticles in a controlled manner.

This nanoparticle was fabricated by the scholars in the labs of the Biosciences and Biomedical Engineering Department of IIT Indore under the guidance of Dr. Sharad Gupta. E-capped SPIONs and their novel synthesis has demonstrated such varied applications that they are receiving a US patent for the same.

Their team is currently researching similar green synthesis methods for gold nanoparticles and the biosensing applications of copper nanoparticles, hoping to make more advances in the field of bionanotechnology.

"The extract from the leaves of the Pimenta dioica function both as a reducing agent and a stabilizer in the green synthesis of SPIONs."

Myrtle pepper leaf used for synthesizing the nanoparticles by the researchers at IIT Indore

Life, livelihood, and learning:

What higher education will look like in the wake of Covid-19

"If you were to design a place to make sure that everyone gets the virus, it would look like a nursing home or a campus," Paul LeBlanc, the president of Southern New Hampshire University.

Written by **VARUN MADHAVAN**
Designed by **SOHAM SAHA**

The current pandemic has ground the world to an abrupt and unpleasant halt. Infected numbers are rising fiercely in India, showing no signs of slowing anytime in the near future. People are dying by the hundreds every single day. The economy is reeling from the effects of a complete shutdown of nearly all economic activity. In the midst of all this, we have to continue our education.

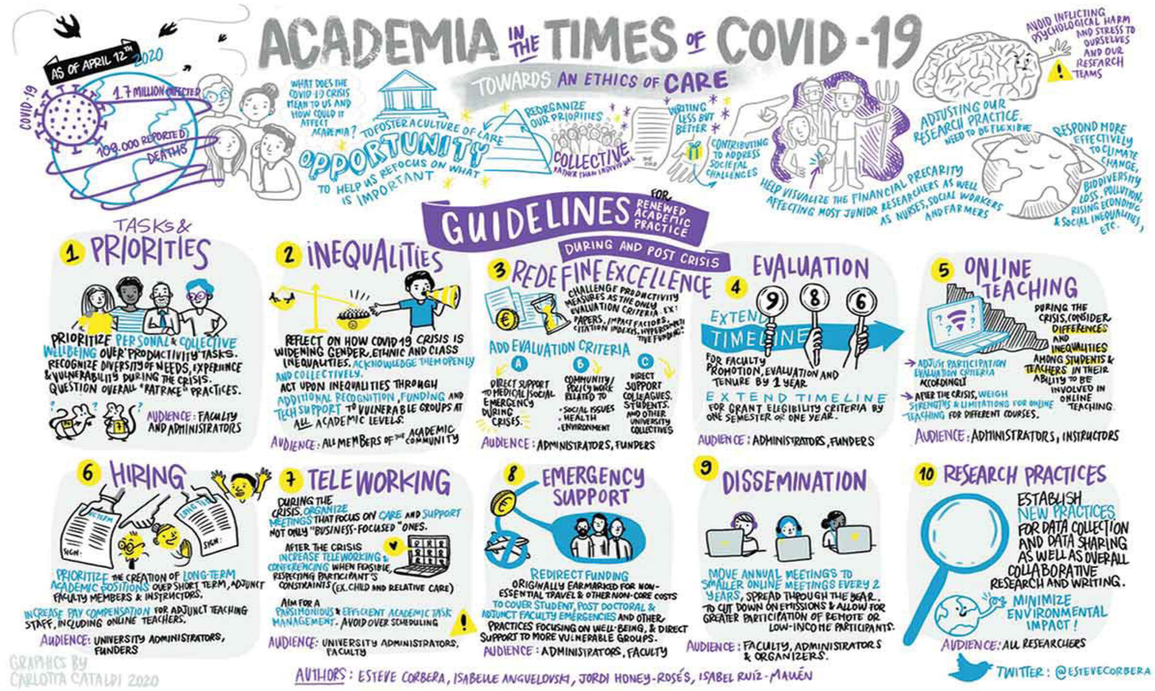
Over the past few months, all education, from the school to the college level has either been on pause or has been conducted in the **now-normal, online format**.

Is it actually possible to learn online?

While a good percentage of classes can technically be held online, the online teaching paradigm has a number of serious limitations. Interaction between students and teachers is virtually non-existent in the online teaching paradigm. And even assuming theory lectures can be held online, Engineering is inherently a practical subject that can't be learnt meaningfully without laboratory courses which are of course quite impossible remotely.

Frustration of staying at home, missing college life and hanging out with friends aside, why is it actually necessary for colleges to transition to at least some semblance of normal?

These problems make us wonder whether it is even worth the trouble of attending an online University. If college education could be reduced to a bunch of videos and assignments, then how are our fancy college degrees better than online MOOC certificates?



Graphic credit : Carlotta Cataldi

Academia in the wake of Covid-19

Students are hardly the only component of academia. Researchers have also been affected by the pandemic. Researchers at Times Higher Education have initiated a study to explore the challenges faced by academics due to the ongoing pandemic. For academics across the world, the pandemic has forced a near 100% move to remote work.

Preliminary findings reveal three main problems -

1. Academic Tunnel Vision

Governments, Universities, philanthropists and organizations have been (quite understandably) pouring money into funding Covid-19 related research. Clinical scientists have been mandated to temporarily cease research activities so that they can be redeployed into medical practice. And many clinical trials have been paused or terminated early to ensure patient safety. In addition, almost all conferences across all fields have either been postponed or have been shifted to a purely online mode. While it is true that even small breakthroughs would go a long way in restoring the world to normalcy, there have been concerns among academic researchers that extreme focus on the pandemic would mean less funding and attention for some of the other major challenges humanity faces. It must be kept in mind that mankind has had countless problems before Covid-19 and will continue to do so long after the pandemic is behind us. Throttling or diverting funding earmarked for other research such as Climate Change or treatments for chronic medical conditions could have serious implications down the line.

2. Can research even be conducted online? -

Some kinds of research are inherently impossible to conduct in isolation, without access to equipment and labs. In addition to this, even with video conferencing and other online tools, it is difficult to effectively collaborate with large groups of people without face-to-face discussions and brainstorming.

"Any tendency towards reinforcing a research monoculture based around quantitative work is likely to be exacerbated, while undermining multidisciplinary research", the study claims.

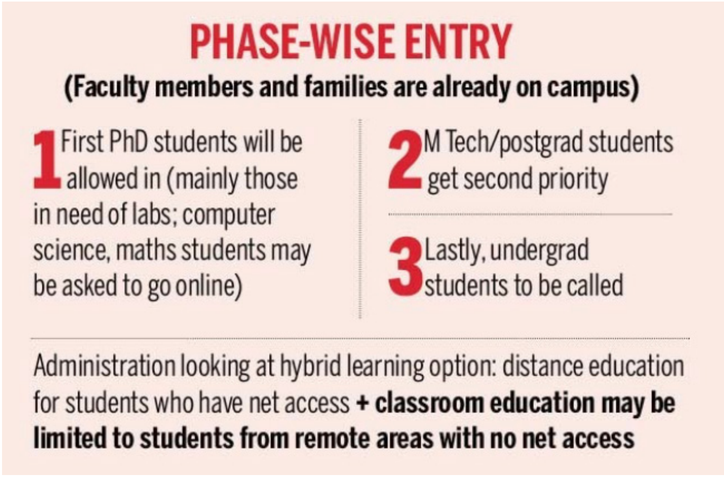
3. Teaching online

Most researchers also devote a considerable portion of their time to teaching classes. With the move to the inherently trickier online teaching paradigm, professors have to spread more of their time on teaching. This is decreasing the amount of time they have available for conducting original research.

What happens when we do reopen?

University campuses are inherently designed to facilitate and encourage the interaction of a huge number of students. Students live together, study together and learn together. Classrooms provide a level of interaction and understanding that an online video couldn't even hope to match. Our hostels house a large number of students eating, playing and enjoying life together.

Source for image : Times of India



However, in the words of Paul LeBlanc, president of Southern New Hampshire University - "If you were to design a place to make sure that everyone gets the virus, it would look like a nursing home or a campus."

Let us approach the challenges of reopening campuses and how University authorities have proposed addressing them sequentially.

First, we need to get the students from their homes across the country to the campus. It is evident that this in itself would be extremely risky, even following recommended safety precautions. There is a good chance that travelling itself would expose students to the virus.

Once on campus, students cannot be immediately allowed to return to normal activity. Travel would likely have to be followed by a lengthy quarantine period (as of writing this, most states enforce a 14-day quarantine for people travelling from other states), which would be immensely difficult to enforce since the on-campus medical facilities are nowhere near large enough to handle such a large number of people at once. Universities have proposed a staggered approach to address this.

Students would be invited back to campuses in a phased manner - first the PhD students, then the postgraduate students and finally the undergraduates. By keeping a safe period of time between each phase, campus medical authorities would be able to handle the influx of students at a given time.

Now let us assume everyone has reached campus, has been quarantined for the required period and as of now none of the students are infected. But even now there remains one major potential source of infection, i.e. the non-teaching staff - our beloved mess dadas, hostel-workers, rickshaw-walas, security guards, etc. In recent years, the on-site housing capacity of campuses has already been stretched thin due to the increasing student intake year on year. It is not possible, or at least not easy, to provide in-campus residence to the non-teaching staff. In coming in and out of campus on a daily or even semi-daily basis, even with the strictest of temperature checks, masks and sanitization it is quite possible (and perhaps inevitable) that the virus may slip through and infect the students.

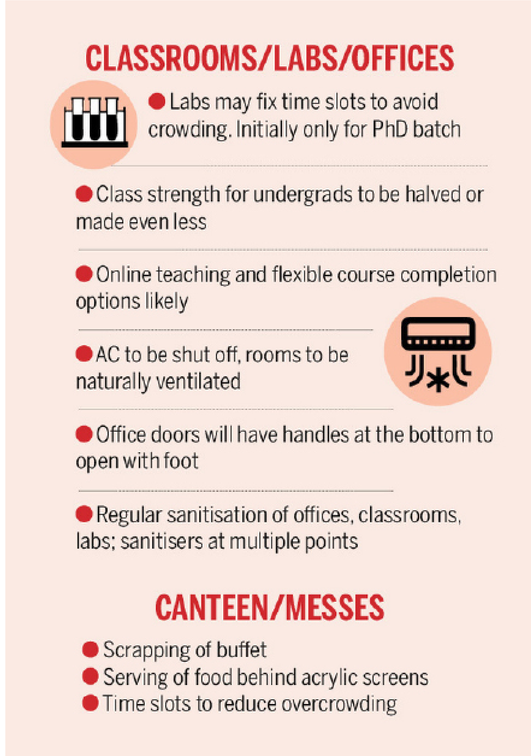
All it takes is one crack. With the densely-packed hostels and classrooms, even a single infected person could potentially infect tens of people directly, each of which would go on to do the same. Due to the largely asymptomatic nature of the disease in our age group and the high interaction of students with each other, the virus could have spread to a huge number of people even before we realize that there is a problem. The situation would spiral out of control very quickly.

This brings us to a rather interesting, though grim, question.

Who is to blame if a student dies?

Moral liability aside, institutions could face legal trouble if they fail to provide a safe environment for their students. Dr Abhik Majumdar, a faculty member at the National Law University, Odisha, elaborates on a range of possibilities. "The liability of an institution depends on whether or not it reopens following a government order; whether the order in question is mandatory or merely an authorisation given to institutions to reopen at their discretion; and whether the institution is a private or a state body."

If the Govt. says educational institutions **MAY** reopen at their discretion, liability is solely on the institution. Private institutions especially might face legislation in this case. If the institution is Government run/funded one like the IITs, they are still responsible for ensuring that safety measures are provided and enforced. If they fail to do so, they CAN be held liable.



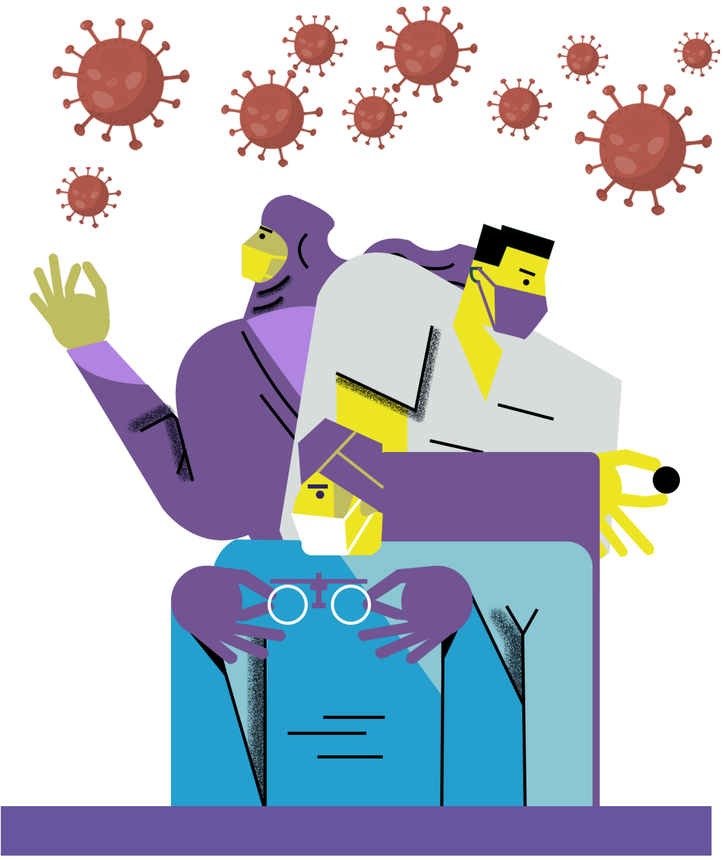
Source for image : Times of India

Other considerations

Numerous studies have shown that older people are the worst affected by the virus. This means that our beloved Professors are most at risk. Knowing this, can we really ask our Professors to risk their lives by teaching class after class of students, any of whom could be infected or carriers? In fact, several Professors at colleges across the world have straightaway refused to return to the in-person teaching paradigm in the absence of a cure or vaccine, even with strict social distancing measures.

Approaches to reopening

Universities across the world have proposed reopening, at least on an online platform, in a variety of ways.



Fully Online semesters

Due to the above problems being especially prevalent in a heavily populated country like India, (as of writing this) most universities in India are planning to have at least one semester in the fully online format. IIT Roorkee has also proposed shifting the lab courses to a later semester, focussing only on theory courses that can be taught online. To address the problems of lack of requisite hardware or connectivity for some underprivileged students, IIT Bombay is tapping its huge alumni network for support. This, in particular, is a move we can expect other institutes to make. The Government itself may provide funding for the same. But even with financial support, some students live in remote regions, where it is physically impossible to get a stable enough internet connection or even 24/7 electricity. To enable the learning of these students, IIT Delhi has proposed residence on a 'need-to' basis - those facing such unavoidable problems will be given the option to stay on campus. Students will also be given the option to defer one or more semesters to a later date.

While these measures have been announced by individual IITs as of now, it is expected that they will be standardized across all of the IITs and possibly other institutes in India as well.

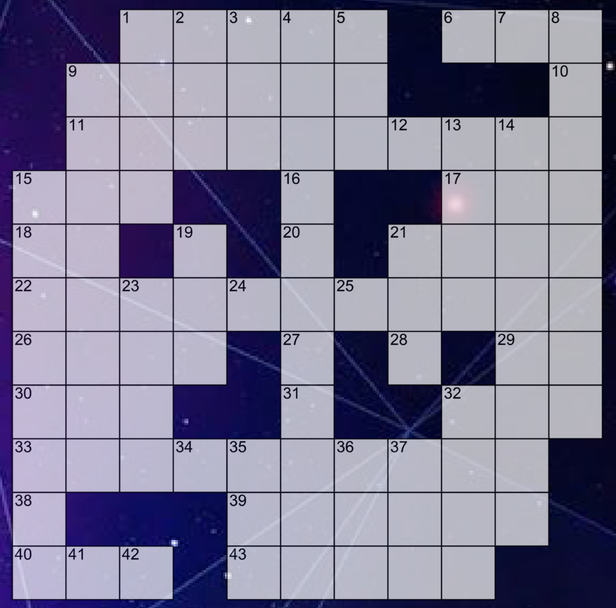
It remains to be seen how an online semester would work for the upcoming first years. With the JEE exams deferred to September, it is likely that the first semester for first years would start only in early 2021.

What would our campuses look like when we do reopen?

So there are clearly challenges and risks involved in any level of reopening. Staying locked-down is imperative to preserving our lives. But will the saving of our livelihoods and learning have to take precedence at some point?

CROSSWORD #2

Credits: Agni Keyoor Purani



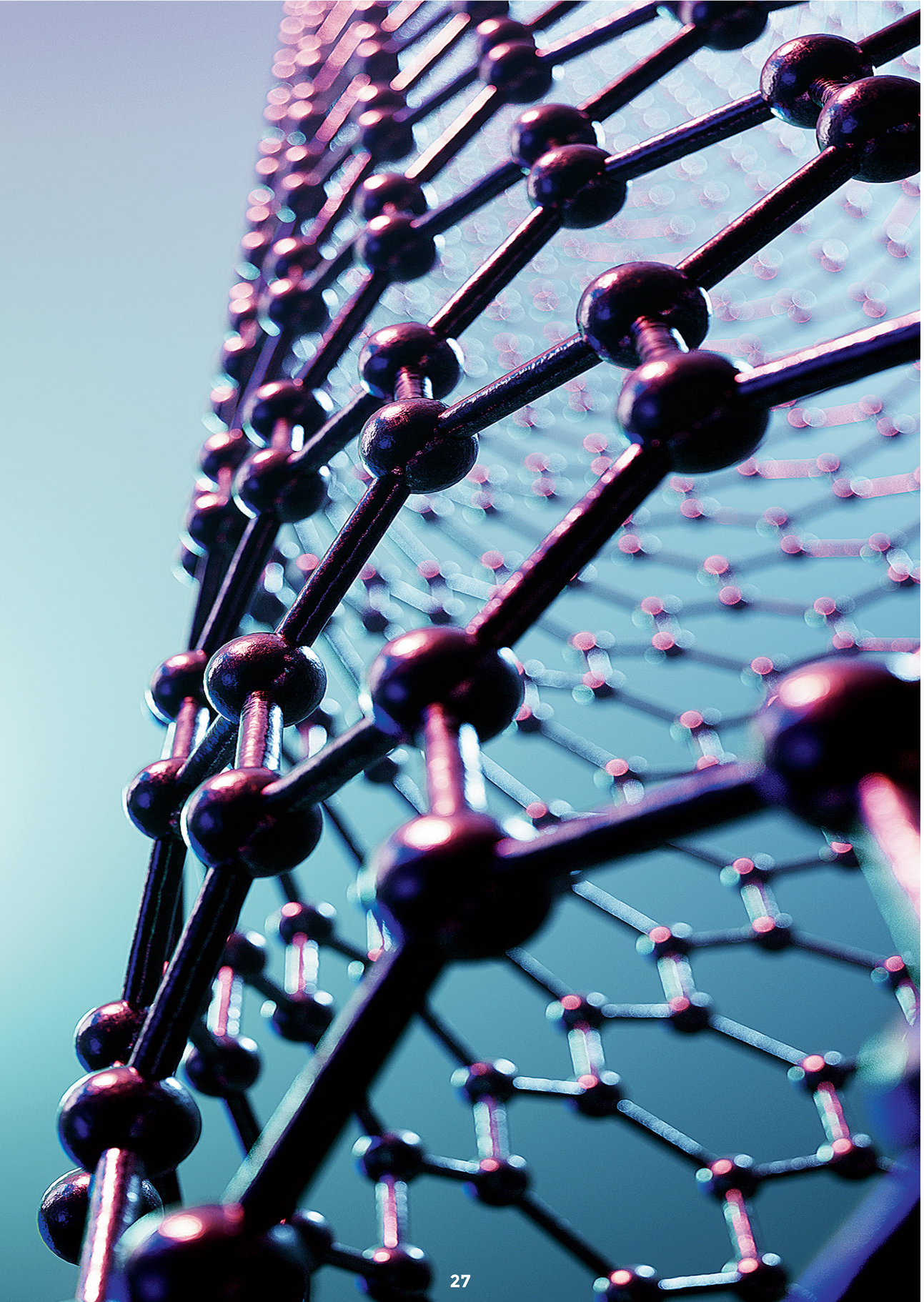
Across

1. A famous greek philosopher who believed in love without sex! (5)
6. If a computer has short term memory loss you would have to replace this part. (acronym) (3)
9. This is an 'esteemed status' which pluto has strived to attain, only occasionally having been denied it by the International Astronomical Union. (6)
11. This elementary particle is responsible for your mass. (5 + 5)
15. Improvised version of a similar text based editor. (3)
17. The commonly used abbreviation used to refer to the time at the Royal Observatory, London (an acronym) (3)
21. A family of medium to intercontinental range ballistic missiles developed by India, named after one of the five elements of nature. These missiles are guaranteed to rain 'fire' upon our enemies. (4)
22. A phenomenon seen in cadavers involving the stiffening of muscles owing to the hydrolysis of ATP in the muscle cells. The occurrence of this phenomenon can be used in forensics to determine the time of death and whether the body has been moved after death. (5 + 6)
26. A vendor neutral file format that allows the exchange of information among different CAD (Computer Assisted Design) softwares. It involves a specification of the initial graphics of the model which is to be shared. (4)
30. An abbreviation for the resistance developed by microbes to drugs intended to eliminate them. (3)
32. TRUMPet of the United States (an acronym). (4)
33. Converts a human understandable text to an identifier (like an IP address). (4 + 6)
38. A sublimable solid commonly used to preserve things at low temperature without adding moisture to it. (3 + 3)
40. A fly needs approximately one unit of this to perform a "push-up".(3)
43. A tiny piece of land which is usually too small and without much vegetation (5)

Down

1. An imaging technique similar to Fluorescence-lifetime imaging microscopy but based on phosphorescence rather than fluorescence.(an abbreviation). (4)
2. A delay which is irritating if you play online games. (3)
3. Made a film on pi. (3)
4. These are used for measuring the magnetic field intensity at a point in space (plural). (5 + 6)
5. A file extension that was designed by the company that made the strongest phone in the world. It was used to send pictures as a series of one or more concatenated SMS text messages. (3)
8. The part of a fractional number that follows the decimal point. (8)
9. 500, 200 (HINT: This is how Euclid would write). (3 + 5)
13. A serum found in the liver and kidney (an acronym). (4)
14. An animal that can eat both plant and animal based food. (8)
15. A measure of the deviation of a set of values from its mean. (8)
19. A set of software libraries that easily helps you do low level hardware control (an acronym). (3)
21. A smooth curve joining two points. (3)
23. Coronavirus is a ____. (4)
32. An uncommon short form for a quantity with direction. (4)
35. Similar to HDMI but used mostly by professionals and in production environment (an acronym). (3)
36. a.k.a. Return of warrior (acronym). (3)
37. If you think you can die to win a prize by solving this crossword before anyone else, you ___ for the prize. (3)

Answers of crossword #1:



Log 9 Materials:
Unleashing the benefits of Nanotech & Graphene

Log 9 materials, founded by IIT Roorkee alumni, is a nanotechnology company which focuses on 100% green renewable energy and filtration applications of Graphene.

Written by **AKSHARA SINGH, ARPIT MAHESHWARI, MALIKA RASHU**
Designed by **SOHAM SAHA**

Log 9 materials , the startup we're going to talk about in this article, was incubated by IIT Roorkee in its business incubator TIDES.

The World of Aluminium -based Fuel Cells

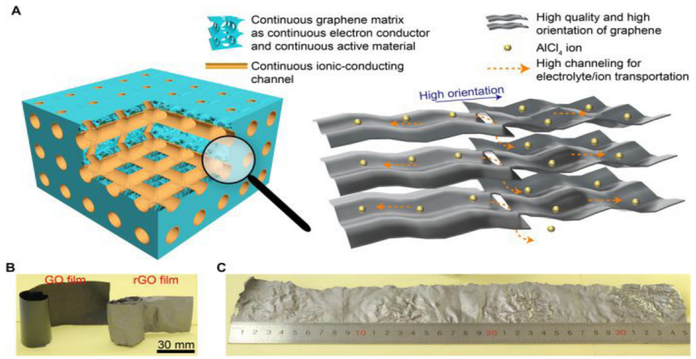
Aluminium fuel cells primarily use three components – aluminium, water, and carbon in the form of graphene. In simple words, there's water between layers of graphene, and when aluminium comes in contact with water, it corrodes – releasing energy.

These systems use aluminium as an anode, oxygen as the cathode, and water as an electrolyte. A porous membrane made of graphene- thin, light, strong, and an excellent conductor of heat and electricity- lets the air pass into the electrolyte chamber where a chemical reaction between aluminium, water and air (oxygen) takes place to release energy.

The basic chemistry of aluminum as a fuel relies on a reaction with water to generate hydrogen and heat according to the following:

$$2Al + 6H_2 \rightarrow 2Al(OH)_3 + 3H_2O + Q\ (Heat)$$

This reaction releases approximately 84 MJ/L of energy (almost evenly split between heat energy and potential energy in the form of hydrogen), which is more than twice the volumetric energy density of diesel fuel, and more than 3.5 times that of lithium.



Aluminium fuel cells : Aluminium fuel cells primarily use three components – aluminium, water, and carbon in the form of graphene.

The technology being developed by Log 9 Materials plays into the larger trend of decentralisation of energy across the world. Such micro power plants will likely cover energy sources such as solar, wind, geothermal and, now, metal-air energy.

Decentralised energy creation should lead to an energy internet that could create an entirely new class of opportunities for economic growth and innovation.

Clean fuels: Caring for the Earth

Batteries and combustion engines each have distinctive benefits and limitations. Batteries have simple construction and operate silently; however, their energy density (i.e., the energy per unit volume) is poor, and lithium-ion batteries are potential fire hazards. The energy densities of combustion engines are higher than those of batteries, but combustion engines are relatively loud and emit toxic gases.

The energy system that employs an aluminum-based fuel is potentially safer, more reliable, and easier to refuel than alternatives. Additionally, an aluminum-fueled power system is simpler to start up and shut down than gasoline engines, and the system operates in extreme environments such as beneath the sea.

Another benefit of this technology is that the aluminium plates are exhaustive in nature and at the end of their useful life, they turn into an oxidized powder that can be sweltered into aluminium plates again. Hence, that actually makes the spent fuel recyclable.

The idea is to not only use these batteries to power cars but also to replace diesel generators that are used to power cellphone towers, ATM kiosks, and often meet household energy demands in India. Looking at the bigger picture, these batteries are the key to a brighter future.

For the auto sector, Log 9's pitch is simple. Electric vehicles that run on Li-Ion cells need specialised charging infrastructure sorely lacking in India which has only recently achieved 100% electrification. The current breed of EVs can't cover long distances without being charged frequently. They promise a range of about 100 km to 200 km per charge with exceptions like the expensive Tesla cars that deliver over 500 km a charge.

There's also a strategic advantage switching to metal-air batteries. India does not produce lithium and cobalt, the raw materials that go into making Li-ion batteries.

At a macroeconomic level, the benefits of using materials that can be broadly sourced locally to create energy solutions will directly impact GDP, fiscal deficit, and energy security and, thereby, national security.

Wide array of Applications

Log 9 Materials specializes in nanotechnology-based innovations mainly based upon graphene- an allotrope of carbon. It is this area of their core expertise that has seen some fascinating innovations through various products. The major reason why commercialization of graphene has lagged is the cost intensive processes that make it commercially unviable. This is the area where their research and innovation has made a profound impact and reduced the expenses involved. Thus, they manufacture graphene on a large scale and incorporate it in their product to realize its value.

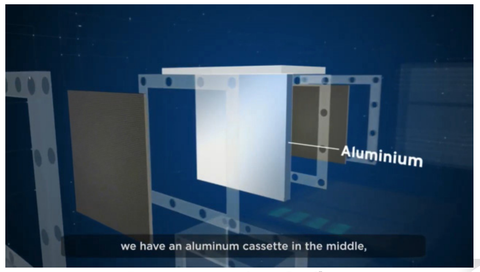
Conventional electric vehicles require electricity for charging which again comes from thermal power plants based on fossil fuels. Also, the non-conventional sources of energy like wind and hydel require batteries to store power which ultimately end up in landfills. These are not end-to-end sustainable sources.

The scenario is quite different for aluminium fuel cells. They have an aluminium cassette in the middle and graphene membranes on both sides. The graphene membranes keep carbon dioxide out, while letting oxygen in. When energy is required water flows in and oxidation of aluminium occurs producing aluminium hydroxide as a by-product and evolution of energy occurs. The by-product can be re-smelted back to aluminium. Such a fuel cell can provide energy for a car to run 1000 km without any need for recharging.

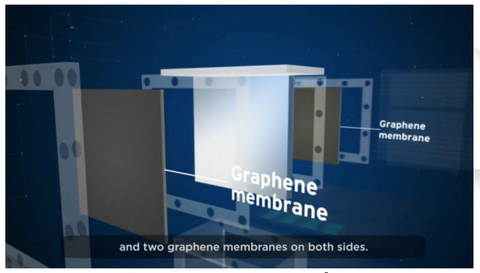
Log 9 Materials has also offered solutions in the oil spill clean-up domain in the form of LOS (Log9 Oil Sorbent) which is a graphene based oil sorbent pad. Conventional synthetic pads based on polypropylene offer absorbance upto 20:1. An absorbance of 'x' implies 'x' gram of oil can be absorbed by 1 gram of pad. This absorbance, on the other hand, has an exceptionally high value ranging upto 86:1 for graphene-based pads. An important aspect of such pads is their recovery and surprisingly these pads can be reused 7-8 times depending on conditions.

The latest innovation of Log 9 Materials is the "CoronaOven" which has been certified by the ICMR empanelled lab CSIR-CSIO. It uses chemical-free multi focal UV light exposure covering the item from multiple sides inside the chamber including the bottom. A 253.7nm wavelength of UVC is used here which has various germicidal applications.

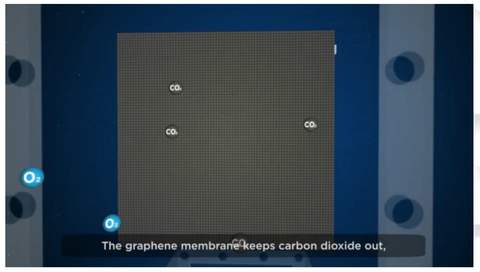
So how is it different from the UV sterilization boxes already in use at hospitals and saloons? The answer lies in the fact that most UV boxes in market, in saloons and in hospitals are designed for broad spectrum UV light and not specifically for delivering 254 nm UV light. Moreover, UV light placement in such boxes does not ensure 360- degree irradiation.



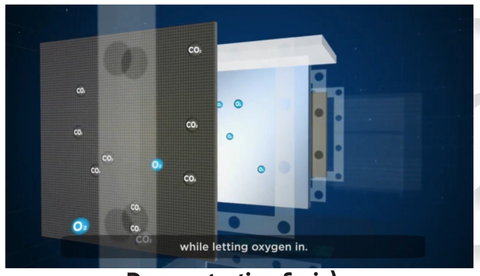
Demonstration fig i)



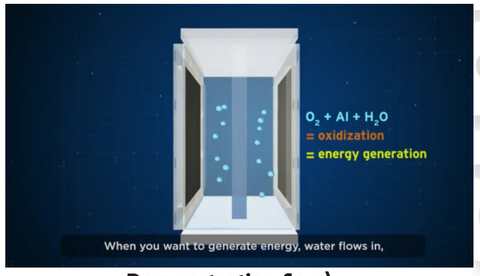
Demonstration fig ii)



Demonstration fig iii)



Demonstration fig iv)



Demonstration fig v)

Demonstration fig : the detail demonstration of log9 material.

This leads to generation of shadow areas on objects placed inside these boxes which leaves patches of unexposed surfaces making such UV boxes unsuitable for decontaminating all surfaces at the same time. But CoronaOven's unique 360-degree illumination design ensures that each point on the surface of an object placed inside the CoronaOven receives the required wavelength and the required UV dose without generation of a shadow area.

It is available in two variants differing in the volume it can hold. The 33 litre variant is available for sale online at Rs.14399 whereas the 20 litre oven at Rs.10999. As the fight against the virus gets tougher, it can provide an immense leap forward.

From humble beginnings to a promising future

Log 9 Materials was incubated by the Technology Innovation & Development of Entrepreneurship Support (TIDES) Business Incubator at Indian Institute of Technology, Roorkee in December 2015.

Founded by Akshay Singhal and Kartik Hajela they has acquired 16 patents in graphene synthesis and graphene products.

They are a determined team of scientists and engineers working on commercializing Graphene. The development of new frontiers in Graphene synthesis of various forms, reduction and functionalization and designing innovative applications paved the way for the foundation of the company.

Since inception in 2015, Log 9 Materials has attempted to solve a myriad of practical and real-life challenges with the novel use of graphene nanotechnology. While in the initial years the startup experimented and developed product prototypes in a variety of domains, it has narrowed down to only two sectors in the recent past – filtration and energy.

The IIT Roorkee spin-off has raised seed funding in March 2017, followed by pre-Series A funding of around Rs 3 crore in 2018. Recently it has raised a fresh round of Series-A funding of Rs 24.22 crore from Sequoia India's scale up program Surge and Exfinity Venture Partners. This is the third round of funding raised. The company has said that the fresh funds would be utilized for product advancement of the aluminum fuel cells they are developing.

Log 9 materials was awarded "the most innovative technology of 2018". Akshay Singhal and Kartik Halega, the cofounders of log9 materials were listed in the Forbes 30 under 30 list - Asia: Industry, Manufacturing and Energy - in 2019.

A vision for a better tomorrow

The ultimate objective of Log9 is to transition towards an aluminium-based cleaner energy economy that will shift dependence from crude oil and fossil fuels for energy generation and storage.

The startup states that its aluminium-fuel cells have the potential to revolutionise the clean energy, electric mobility, and transport sectors in India and across the globe. It is a primary energy generation technology similar to a hydrogen fuel cell, but more economical, safer, and scalable.

The startup is, in fact, poised to enter the multibillion-dollar (quote exact figures with source link) energy sector that's on the cusp of a change towards cleaner sources of power. Akshay Singhal, in an interview, said that the firm will be using the funding to propel development and deployment of their flagship project on aluminium-air fuel cells, which is currently in the optimisation stage.

"Our endeavour will be to accelerate modifications in the product development cycle so as to create a commercially viable product for both electric vehicles (EV) as well as stationary applications." he said.

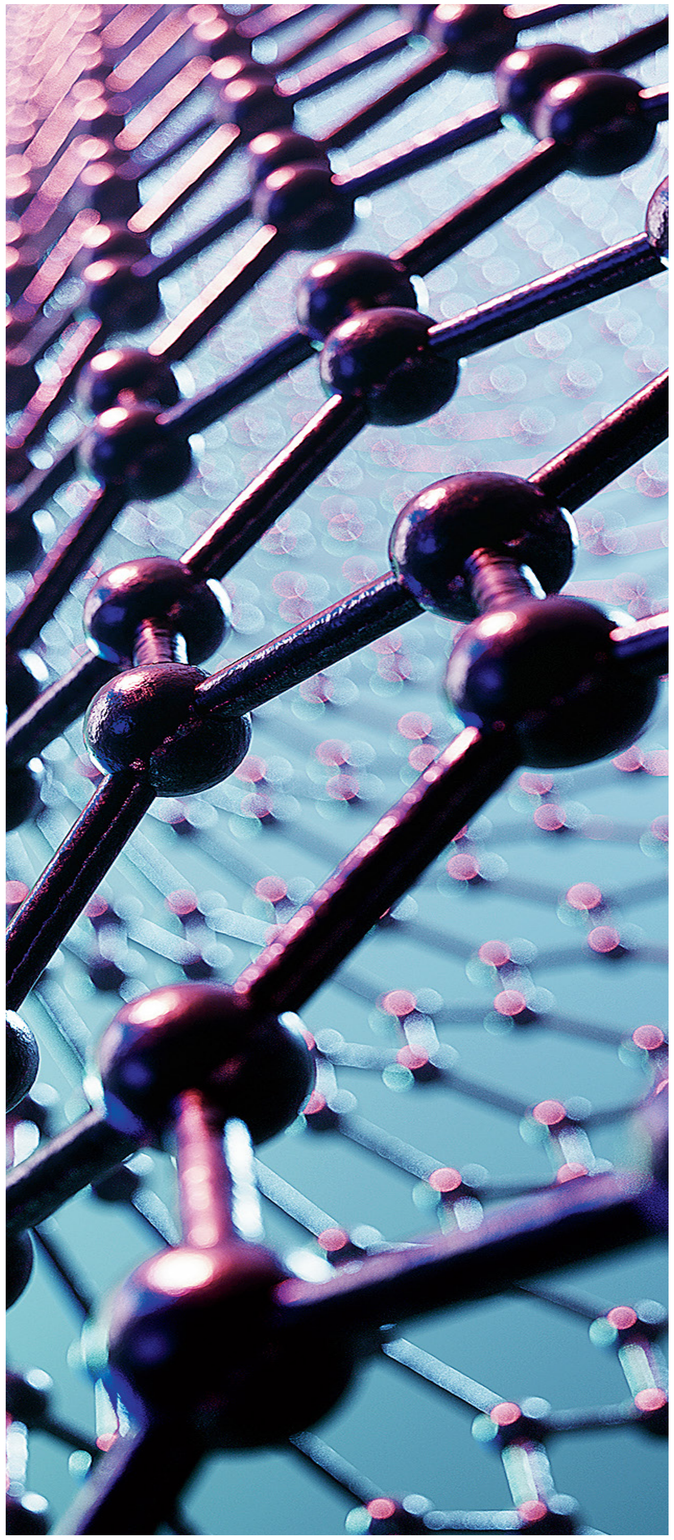
A team of 45 people at Log9 Materials is working towards getting the aluminium fuel cell tech on the road. The start-up is already in talks with OEMs which have expressed interest in the technology and are likely to begin trials in the first quarter of the coming financial year.

According to Anandamoy Roychowdhary, director – Technology, Sequoia Capital India LLP Log 9 is building the future of energy. "Their tech can help us harness aluminium and will result in a 100 percent recyclable energy future that is safe, free of distribution calamities risk, and generates zero waste – and hence, fully sustainable. The possible adoption of an aluminium economy that could greatly alleviate the current climate change problems that beset us today is a future that Log 9 is looking to enable."

Log9 Materials is also working on improving the efficiency of its batteries so that it can deliver a range of 1,500 km per charge and reduce the size of the battery three-fourths. The battery currently takes up the entire backseat of a Mahindra e2o microcar and the aim is to shoehorn it into the boot or take it under the car. The batteries cost up to Rs 3 lakh.

The technology still has a few hurdles to overcome before it can replace Li-ion batteries in mainstream applications, though. For instance, once they are switched on, metal-air batteries can quickly lose charge. Some of these challenges are being addressed.

"There's a lot of R&D that is going in but we'll be in the market soon," says Singhal.



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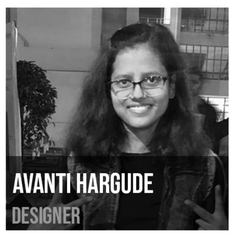
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