insight

MMA

DHATUKI

Department Newsletter 2016
Metallurgical Engineering and Materials Science

What after graduation?

Well, you have more options than you think....

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WHAT AFTER META AT IITB?

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What after college? There comes a time during the course of one's undergraduate programme that post-college plans begin to dawn upon every student. And, a myriad of options – higher studies, startup, MBA, etc. further complicate his/her plight. It is very natural to get confused while thinking about them. For many, core metallurgy and materials science is fascinating. For others, it is not. Some of us want to make money. Some want to try their hand at entrepreneurship. For some, the constancy of a 9-5 job isn't quite appealing.

When we joined IIT Bombay, we were thrust into a world much more mysterious and diverse than our schools.

Our own experiences inform us that the institute, and our department in particular, has been our source of strength. Optimistically enough, the experiences of our seniors tell us the resources give us all a robust level of preparedness to make a suitable choice.

YASH SHETH

Batch of '14

As much as we love our campus & wish never to graduate, there comes a point in time where you have to bid adieu to it. Now you would ask, what was so unique about me graduating from campus that makes this transition different from others, I was not only relocating to a different country but to a place with a very different culture from ours and had it not been for the exposure I gained at IITB, I am unsure as to how I would have survived.

After graduating from Meta@IITB, I joined Taiwan Semiconductor Manufacturing Company (TSMC) as a process integration engineer at their Hsinchu plant in Taiwan. The job entailed me to definevarious processes and integrate the process teams to meet customer target specs. It involved monitoring the line performance of production of chips & performing root cause analysis when performance did not meet process capability. I worked there for about 10 months, but as much as I loved working in the core space, I realised it wasn't my true calling. In pursuit of exploring other options while still at TSMC I stumbled upon a course on Supply Chain Management (SCM) on edx.org and took aliking for it. Through networking I found an opening at Apple in SCM role and applied for the job and here I am, since June '15. At Apple I work as a Demand Planner for the Apple Watch for APAC region. In this role we use trend analysis and other forecast techniques to assess the demand risk or opportunities to maximise sales of the product with optimal inventory efficiency. This role involves collaboration with several cross - functional teams including Worldwide Supply / Demand Management in Cupertino, Reseller Operations, Logistics and Retail Operations. The current role is very much non-core but there are a lot of things learnt during the core study that have helped me in this role.

Since I was a dual degree student had the benefit of an additional year to determine what it is exactly that I wanted to do. To be honest I still haven't figured that out yet but the current role is very much in-line with what I would want to do in future. Going back to the discussion while I was at IIT, I had done all my internships in the core field with 2nd year at Carborundum Universal in Bangalore, 3rd year at Tanaka Holdings in Japan and 4th year at Trinity College Dublin in Ireland.

During all these internships, I was exposed to numerous core concepts and the fact that I worked in international teams helped me learn adaptability, flexibility and readiness to embrace new ways of working. At the same time, it allowed me to explore other cultures and customs and blend in them.

A lot of these internships place a high regard on the CPI you have, so even if you don't have a good CPI yet, fret not, start putting in effort NOW.

I began with 6.91 in the first semester and graduated with an 8.65, all you need to do is be religious on your study schedule and don't procrastinate. As far as Meta department goes, it is by far one of the best departments in terms of study-activity balance. The key to acing the courses is to attend the lectures and making notes. I've tried it and it really helps to keep things in mind if you make notes yourself.

The profs are really helpful and easily approachable for advice on both your core and non core related queries.

During my time as a DAMP coordinator, I interacted with almost all the professors in our department and I felt that profs do understand the students' situations. All we need to do is to go and ask for some help.If I were to end this piece with key actionable items in your years to come at IITB they would be:

1. Attend lectures and make notes, firstly making notes keeps you awake in class even after you had a night-out and they help you save a lot of time and frustration when exams are near.
2. Push your friends to get the best out of them and ask them to do the same to you.
3. When you choose to do something give it your 100%, you never know when and how it might help you in future.

DIVYA CHOUDHARY

Batch of '16

I never started off as a core enthusiast,& it's very difficult to say what exactly made me one. Up until the endof my sophomore year, all I wanted was to get good grades and go to a B-school. A series of events happened.

The courses became pretty intuitive & interesting. During my third year intern at Tata Steel, I realized that I would probably want to work for a core company before considering an MBA. This made me take up a B. Tech Project in my 7th semester. That's when things changed completely. I worked under Prof. Yella on organic-inorganic hybrid perovskite materials used in solar cells. Her encouragement and guidance always kept me on track and changed my perspective about core research environment. Also, my PhD mentor, Sateesh, was extremely helpful.

While applying to universities, the only problem I faced was the lack of database of the students from our department who went for graduate studies. It sort of makes it difficult for you to set the bar on test scores and overall profile. Hence, it affects your choice of universities because you either tend to apply to too ambitious places or too safe. The one thing people might face problem with, fortunately I didn't, is the Letter of Recommendation. The professors in our department are generally very supportive and would write glorious LORs if you really do work hard. You might not get results from your work but serious effort is what they value.

My program at Cornell University is Master of Engineering in Materials Science. It's a professional program which is aimed at students who want to work in the core companies. It's intensive coursework and the Master project can be anything- a faculty led project, an industrial project or a design project. All in all, I love this program as it gives you the freedom to tailor your program according to your need and interests.

In a nutshell, there is only one thing that would want to tell all the juniors- It's never too late to get out and do what you want to do.

SUMAN RAO

Batch of '15

Final year students who choose management consulting as their first post-grad adventure are typically attracted to the quick exposure to the business world - across industries and function - which the profession promises, with the generous icing of multicultural exposure, travel and lifestyle slathered on. And rightly so, as I have discovered. As I write this a year out of IITB, sitting at an airport's boarding area, I look out of the glass windows to the runways. As if to prove a point, a thought strikes me – not long ago, when at the boarding airside seats, I would only notice the majesty of the A380 landing. But now my eyes rove more often to the ground operations, the pushback carts, the ramp handling and what not – how many airlines do they serve? Which ones are the high margin guys? Which airline is turning around their plane the fastest? My last project was a mandate to effect a complete business turnaround of a large national airline, and a few months of practically living in an airport has transformed the way I look at the industry. The project before it – different industry, different continent, different problem. Brick and mortar stores, and e-commerce – at a time when the two are competing to the bottom, how do we get them to collaborate instead? Such diversity in the work you do is a defining characteristic of the profession, and it teaches you more than the sum of its lessons - apart from knowledge of those industries itself, consulting teaches you a different way of thinking,a faster speed of ramping up to concepts, and a disciplined way of living when you're always on the move. And if you're lucky, you get a few weeks between projects when the workload can bereally light. Reminds me of just a year ago when at this time of the morning, I would rather mull the merits of sleep as being more important to health than breakfast, instead of mulling over the airline industry!

For a long time – and five years is long when you're 24 - IITB is our home, school, playground, workplace - and to a large extent, identity. And the most striking change of life outside IITB is that you are put back in the midst of people from interesting, diverse backgrounds and perspective. And this is as enriching an experience as any other. Though of course Meta does not prepare you for a non-core job in terms of its curriculum – it is here that I find its most significant learnings. Meta has some of the most resourceful, enterprising, entrepreneurial people in the institute. Whenever there is something beyond the traditional in student life, you can bet your last few dollars there will be someone from Meta on the frontline. The culture of immersing oneself in new experiences, and the relationships built with professors, peers, juniors and seniors is the richest treasure I take from the department, and I feel confident I speak for many of us when I say this.

Tête-à-tête with our HoD

"When our students walk into the department, they should have a sense of belonging. Only if they belong, they will feel good about it. Hence, a feel good factor is what we should bring to the department."

This is the goal that we as administrators are working towards. We want to ensure that there is more interconnect between the students and the department.

You are here- that is, in the institute- by choice. One shouldn't worry about the branch alone. Your branch has got some connotation, but that is not the end. The institution matters. You are in a great institution by choice. Are you making better use of it? - this is a question that I'll keep posing to all my students.

How is meta@IITB different from other top univs around the world?

I have been to a few universities around the world and I can tell that the only difference I found was their 'work commitment' - that seems to be the only issue. The attitude towards work- be it research in their labs or homework assignments- which people bring over here is a little on the lower side as compared to those top ranked universities. I for one, think that the quality of research in our department is at par with the best in the world. After all, quality is essentially guaranteed output over long periods, in which the research scholar community of our department has been quite successful.

In addition to all of this, we have made one thin film lab. It is not taught in most of the top universities in the world as a part of the UG curriculum. We want to make such efforts from our side so that people actually learn hands on.

ON CAMPUS LIFE

I would think that the campus life right now is much better as compared to mine back then as a BTech student. The facilities are far better nowadays. But I have to agree that we weren't under any major pressure- just a bunch of happy go lucky people. Today, you are under so much pressure. Moreover, now you don't have to wait for a professor to give you information. Instead, how you apply it is more significant than the information itself. In our times the scenario was very different.

ON RANKINGS

Primarily, we are being judged on:

Quality of students- They are the ambassadors. If alumni of meta IITB do very well in all their endeavours, the department will also rise up in the rankings.

Quality of research - I feel it is at par with the top ranked universities in the world.

Infrastructure - It is a work is in progress.

But, I don't worry about numbers. For me, all that matters is the satisfaction level of the student community of my department. If they aren't happy, then numbers don't make sense.

Changes that need to be brought about in our curriculum

But, for ensuring that our students get the best exposure to the core field of materials science, we are trying to make the undergraduate programme give a little bit more hands on experience. Until and unless we make the UG lab experience better, the student is not going to appreciate it and unless and until he appreciates it, how would he feel interested in it and consider it as a future career prospect? Better exposure to hands on work is the key. Metallurgy as a branch is an experimentally intensive discipline so the students need to perform these experiments and in the modern day it is not enough if you do only experiments. You also have to be good at computations and analytics.

With an improvement in the undergraduate academic experience, the student will be able to get a full choice. Right now I feel that the student is not getting the complete choice of what he should be.

On why a large number of meta students choose non-core

I would rather try to advocate how in your career, the training that you have received has helped. After all, everybody can't be scientists, designers or researchers. I feel that a meaningful job is what is more important. Are you intellectually satisfied? Are you doing a job which you like to do? These are the questions one needs to ask. Most importantly, are you applying any of the skills that you have developed here? If the answer is yes, then it will make me feel better. I don't want to be ranting on and on and on preaching you people to go for core jobs .

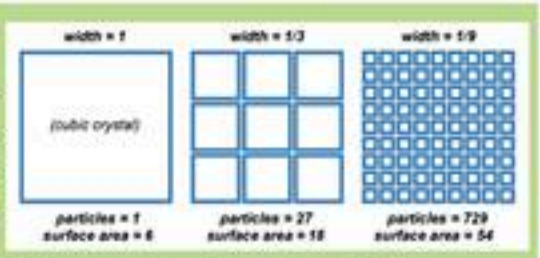
SCALING-UP THE NANO PEAK

Sumit Chhangani is a fourth year PhD student from department of Metallurgical Engineering and Materials Science, IIT Bombay. He did his B.Tech+M.Tech dual degree in Nanotechnology from University of Rajasthan.

"Science and Technology was always my passion and during inspite of having a background in biology in high school, I attended a short term training on synthesis and characterization of magnetic nanoparticles at DRDO Jodhpur during my undergraduate days to get an essence of these fascinating magnetic ferrofluids. Additionally, I decided to work on a project based on magnetic nanoparticles as well. The topic for our project "Nano-remediation of oil spills using magnetic nanoparticles" was inspired from the oil spill cleanup, which also was the TIME magazine's cover issue for the year 2010. This project was presented by our team at a National Conference held in Delhi planted seeds of interest in fundamental research.

What exactly are Nanomaterials?

Nanoparticles – that can be defined as chunks of materials around 1000 times smaller than the width of a human hair – may provide new and important solutions to many of the world's problems. For example, new kinds of nanoparticle-based solar cells are being made that could, in the future, be painted onto the sides of buildings. Or like in the case of my former project, magnetic ferrofluids could be used to clean up oil spills. Nanoparticle-containing batteries can store about 100x more energy than the conventional ones, in the same space.



The power of nanoparticles: surface area increases as particle size decreases

What are the potential problems faced?

Well, these tiny little chunks of materials are so small that they can move around and do things in ways that we don't fully understand. For example, really tiny particles could potentially be absorbed through skin. In the environment, nanoparticles might be able to be absorbed into insects or fish that are at the bottom of the food chain for larger animals, including us.

Before nanoparticles get incorporated into consumer products on a large scale, it's our responsibility to figure out what the downsides could be if nanoparticles were accidentally released into the environment. However, this is a huge challenge because nanoparticles can be made out of different stuff and come in many different sizes, shapes, and even internal structures.

Because there are so many different types of nanoparticles that could be used in the future, it's not practical to do a lot of testing of each kind. Instead, the people within our center are working to understand what the "rules of behavior" are for nanoparticles in general. If we understand the rules, then we should be able to predict what different types of nanoparticles might do, and we should be able to use this information to design and make new, safer nanoparticles."

Currently, Sumit is working on development of novel Ni based bulk nanocomposites to understand the unusual properties associated with the "Nano-size scale" and also on evaluation of their exceptional physical properties as compared to their conventional monolithic counterparts.

Nanoparticles are key focus of research for a large number of novel applications and act as intermediates between atomic and bulk level materials. At the nano level, material properties change as the size of the particles constituting it are changed. This phenomenon can be attributed to their large surface to volume ratio.

How are nanoparticles able to do all of this amazing stuff?

The key idea is simple – what's really important in many materials is their surface, and so the reason to use nanoparticles is that if you take a chunk of a material and chop it up into tiny pieces, there's a lot more surface area in total than if it was just one big chunk. By chopping it up into tiny pieces we can get more, out of small amount of stuff, and do things like make better batteries, build more fuel-efficient cars, and reduce pollution.

How has your experience as a teaching assistant been?

I was a teaching assistant for the course MM 654, 'Nanocomposites' - a topic closely related to my research field, which made TAship a truly wonderful experience for me. The case study presentation, where students group up to make presentations on some of the most innovative nanocomposites, which not only provide them with an insight into these new class of materials but also inspire me to think about their industrial applicability in greater detail. All-in-all TAship has been a great learning experience and has made a better student out of me.

ENTREPRENEURS IN A MATERIALISTIC WORLD

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- This interview kicks off a new series on our Material Science alumni who have gone on to start companies by commercializing the technology developed in their labs.

As entrepreneur Michael Gerber says - "Many people only see problems everywhere they look but the entrepreneur sees opportunities. The entrepreneur in us is more concerned with discriminating between opportunities than he or she is with failing to see the opportunities". For many, entrepreneurship is a means of finding more and satisfying their hunger for learning. For others, it is a means of doing work that can change the world by using knowledge as their weapon of choice. Whatever may be the driving force, entrepreneurs set out for accomplishing their goals and do so on their own terms. It requires hard work and patience to get there but they do it. Discover in this article how a former student from our department set out to chase his dream.

Monil Modi is a Graduate from IITB who took up entrepreneurship in materials science, more specifically coatings as a profession and has co-founded the company AdMat Innovations. We had a chat with him to discover the secrets of his "double life" as academic scientist and entrepreneur.

AdMat Innovations

What is the main product of your company, and what is its purpose?

AdMat Innovations is focused on delivering incredible protective surface coating outcomes to industrial customers. In the process, we also work on developing and manufacturing of coating chemistries using advanced polymers in conjugation with nanoparticles, which add value to the overall performance of the coating . systems. In addition to this, we have also built a strong wing of business around cutting edge paint application techniques which provide great final

What prompted you to go for entrepreneurship in Meta?

Even before starting up this venture, I wanted to become an entrepreneur. I believe the scope in materials is out there for the taking - and the more you dig into it, the deeper you see where the opportunity is.

We picked up a very small area which we understood collectively as a team.

The opportunity has always been there and will continue to be - for any team patient enough to go through a long journey it takes.

What was the inspiration behind the idea of your startup?

I was always enamored by nanomaterials and the promise therein. Much of this got reinforced in the college days, knowingly and unknowingly. I cannot exactly spot a moment that inspired us to do this - it was just a bunch of things that came together at the right time.

But some people have shaped this journey. A lot of the inspiration came from Prof. Parag Bhargava in the early years of college and long discussions with Prof. Venkataramani on what it would mean to build a business in materials, during an incredible entrepreneurial course.

Once we got out there and started to really build a business - a lot of support also came from Prof. Anand Khanna and his team. They provided invaluable guidance in the area of surface coatings, which helped us enter the market with a

What are your views on the startup environment, especially for materials science entrepreneurs?

Personally, I believe there is scope for success in anything that someone is willing to dedicate a good 5 years to, without looking back and doubting too much. But I am not in a position of authority, since we are still finding our feet.

The one thing I see regularly is that people today are way more open to innovation, and believe in the power of experimenting with the new. Cannot emphasize enough how important this shift in viewpoint across the market is for a new product startup.

How long was the process from the "idea" to the creation of the company?

I don't think this is very well defined - it is mostly like a continuum and it doesn't quite matter either. Defining a "commercial launch" for a B2B product company is a bit of a bummer since there is no line separating out pilots, to small scale work and then large scale engagements. One interesting metric we keep a track of is sales cycle/ period and how much shorter it becomes over time.

Our observation has been that we have come from taking more than 12-14 months to make a sale to about 4-5 months on an average. Apart from that, the idea, product development, product, sale are one long continuum and you stop looking for markers that separate them out after a while.

What is the main change in mindset that this venture has brought to you?

Doing an R&D/ manufacturing business beats the glamour out of the word "startup".

It has made us a blunt, sleeves-rolled-up team, primarily focused on the hard-work side of things.

Another big mindset shift has been to focus on very "real" value addition for the client and realizing that if that works out fine, everything else falls in place without pushing around too much.

How did you analyze the market for your product while starting up?

We went out there with our product, met people, got kicked out of meetings for being irrelevant, and then found out how to be relevant (when we got this right, we found out something interesting about the market for our product), and then… went out there again with our product. We are still repeating this cycle today.

What advice would you give to someone with a good idea who wants to commercialize it?

All I want to say is that being patient and accepting what the market throws at you is critical. Restlessness takes you nowhere. I believe it is an ongoing process.

An entrepreneur has that unique ability to find out problems and seek out solutions in every field of life; Material Science is not an exception. With the widespread field offering various tools to revolutionize the world as we see it today, entrepreneurship can hardly fail to bloom.

Prof Milind Atrey, head of SINE - the umbrella body promoting start-ups in IIT Bombay - also had some insights for us, when we caught up with him regarding entrepreneurship in MEMS department:

"Entrepreneurship in MEMS department has been on the rise. This is due to several factors. Students prefer having their own startups to taking up a job. Also, MEMS department is one of the few departments which offer Dual Degree courses. The Dual Degree students, being exposed to an extra year of research, come up with some innovative ideas regarding the subject."

"We've MEMS graduates involved in many startups in different capacities - Healthcare related startups are a big example."

"Sensors and smart materials - technological advances that have the potential to alter our way of life - offer huge scope for entrepreneurship in Material Sciences," said Prof Atrey.

Technology has the power to transform lives. Harnessing the potential of materials science will take us a long way into the future. This is something which probably won't happen till the commercialisation of Material Technology takes place. And what better way to go about it than entrepreneurship?

As pointed out by both Mr. Modi and Prof Atrey, materials have much to offer in the way of solving the problems we face today, as well as financial benefits for the ones who come up with the solution. With both challenges and perks involved in equal measure, core startups is a field that involves solving real life problems. And in a booming country like ours, it is ripe for the taking!

A CAREER IN CORE

Currently Dr. Anand Garde is a Nuclear Fuel, Consulting Engineer. He holds a M.S. degree in Metallurgical Engineering from Syracuse University, & he has completed his PhD in Material Science from University of Florida. He is a Zirconium metallurgist with over 40 years of industrial experience in nuclear materials. He has been a consulting engineer at Westinghouse since 2000. Prior to that, he held various principal and engineering roles during a 23-year tenure at Combustion Engineering (later ABB Inc.) in Windsor, Connecticut, USA. During that period, he was also an adjunct faculty member at the Hartford, Connecticut, branch of Rensselaer Polytechnic Institute.

He is a member of ASM International, the Indian Institute of Metals (IIM) and TMS, the Minerals, Metals and Materials Society and was awarded the American Society of Testing and Material (ASTM) International "Award of Merit" and named an ASTM Fellow in May, 2014. The prestigious Award of Merit is the highest recognition bestowed by ASTM International, formerly known as the American Society of Testing and Materials. Less than 30 of ASTM's 130,000 worldwide members have received the award, which is presented only when the selection committee approves a nomination that meets the highest selection standards. The society recognized his efforts for outstanding and sustained leadership on the committee and for promoting ASTM standardization efforts by chairing and organizing symposia on Zirconium held at numerous sites throughout the world.

"I joined Metallurgical Engineering department at IIT Bombay in 1963 as my first choice in engineering branch selection. A good friend of my father, Principal of Poona Engineering College, Professor G. K. Ogale was a metallurgist. He motivated me to join the field of metallurgy. In Pune, only candidates at the top of the class would get admission to the metallurgy branch in the early 60s. The field was more exciting than what I expected. Problem solutions were rarely solved by equations alone but needed more thinking. Often, multiple solutions were possible that appeared to be equally promising.

I completed Ph. D. at the University of Florida under the guidance of an internationally recognized authority of that time, Professor Robert Reed-Hill. Continuing my graduate study research on zirconium, I have been working in the nuclear industry for the past 42 years. After selecting technical field instead of management, I have achieved the highest technical position in Westinghouse Electric Company (Consulting Engineer) and have volunteered in the committee activities of American Society of Testing and Materials (ASTM International) as chairman of several B10 committees. I became ASTM Fellow in 2014. I have 10 patents and have published more than 70 papers.

Future Scope

Exciting areas in Materials Science have changed over the years. Aerospace materials, Nuclear Materials, Automotive materials, Biomedical materials, Nanomaterials, Semiconductors are some of the exciting areas of Materials Science, in my opinion. After graduating from IIT Bombay, the prospects for both employment and advanced studies are extremely bright, not just within India, but internationally. This factor has remained unchanged for the past 50 years since my graduation. Even the American industry & universities recognize the exceptional quality of IIT education.

Upon winning the ASTM international award of merit

This award gives me happiness and fulfilment of my lifelong work on Zirconium. My involvement with ASTM started in the early 1970s when I was a graduate student and presented my thesis work at the 1973 Zirconium symposium. Subsequently, I was a nuclear fuel manufacturer representative on the B10 committee and later chaired the same committee for six years. Over the years I have organized Zirconium symposia in Japan, the U.S., Sweden, China and India. I can recall that a few years back, a symposium being held in India was particularly challenging due to terrorist unrest in the nearby area; in spite of this, we successfully completed the event. All of this volunteer work would not have been possible without the support of Westinghouse and my former employers

On how IITB transformed him

IIT Bombay made me an independent thinker ready to face any situation and find solutions. When I arrived in the US, it was like landing on the moon: I did not know anybody, everything was totally new and strange to me, there was nobody to guide me and I did not have money. But I had the dream and boldness ingrained in me by IIT education. That was the biggest asset provided by IIT Bombay."

NEW DEVELOPMENTS IN DEPARTMENT

Keeping track of the changes taking place around us is essential to say the least. And our beloved department has undergone quite a few of them over the past few years and many more new developments have been planned as well. In an interview with the Head of Department, Professor N. Venkataramani we unravel the mystery behind all the changes happening right beneath your noses.

"**Renovating the MEMS department**

We want to renovate the department to bring a few common areas to a desirable level of infrastructure. A decent seminar room, two computer classes- to be able to accommodate 120 students so that we can have the entire batch of students doing a particular course at a time. Then, we want to carve out some more faculty research spaces and for that we are reorganizing the space on the first floor as the common classrooms in lecture halls are always available. Classrooms in the department will make way for this.

Apart from that, we are planning to develop the basement with the ground (towards the side of infinity corridor) into a student lounge. And on the ground floor, we are trying to make the mechanical testing as a larger lab by combining a few presently scattered smaller units.

Another thing which we are looking at is to make all department facilities - research/ test facilities- to be available online with respect to the capabilities, booking and hands on approach to them.

We plan to have a smart sensor centre and a corrosion centre added into the department along with the centre for excellence in steel technology because these two are where our faculty is also planning to have many new projects coming up.

Work done till now

All the plans for renovation are ready and we give an in-principle approval. Although we have begun work in some scattered entities, because of fund crunch we are moving to the next financial year. Till now we have been able to get only the smaller projects done.

New department building?

Sure, our department is supposed to get an additional building - CoEST (Centre of Excellence in Steel Technology). There are some equipments which form an integral part of steel technology that need some space within the building so that the students get hands-on training and experience and are not deprived of the knowledge in steel technology due to present infrastructural constraints in the department.

Scrapping of the dual degree programme

I won't call it as the 'scrapping of the dual degree programme'. What I would say is that the dual degree programme is being revisited and a team of two professors is having a full look at the academic curriculum of the programme and its efficacy. It is not being scrapped, per se. We are trying to understand what the various implications of this will be and a proper report is being constituted. And then only will we be taking some action.

On PhD and MTech programmes

We are also trying to improve the quality of the PhD and Mtech programmes that'll help give a forward push to the quality of research as well. We are also trying to see how we can make our research scholars participate in international conferences to make students aware of what is there out there in the world and what they have to do to compete globally. We want the programmes to match the robust international standards.

Convocation ceremony

I think it gives the faculty and the students of the department a fairly one on one chance to interact and a little bit more intimate than the main convocation. These kinds of functions are student driven. If the students are happy about it then so are we. I don't see any major changes in this in the next few years as this has been reasonably successful and most people were happy. The enthusiastic parents' participation was also pretty impressive along with the students."

THE MATERIAL SCIENCE BEHIND SUPERHEROES

-By Karan Trichal

College days are a period when the inner geek in everyone rears its head- glad to finally have found its peers after years of waiting. No sooner do you enter college than the old, buried issue of Batman vs Superman is brought back from the grave, everyone despises Captain America for being a Hydra Agent and the Internet is flooded with memes as to why the Civil War really took place.

The one thing that does change, however, is our reasons for getting so utterly besotted with these mighty specimens of humanity. Where we once used to find glamour in the morality of these dudes, we now salivate over the technology at their disposal. The wonder over their clumsily-imitated supermoves in the cartoons is replaced by lust for the amazing gadgetry which they use in wildly imaginative ways to kick ass, day in day out, no questions asked.

We've all experienced the hypnotic pull of the technology the Superheroes possess. In this article, let's delve a bit into the materials science behind some of the more fascinating facets of the intricate craftsmanship of applied science.

The Iron Man suit

Tony Stark became a household name for a variety of reasons. The billionaire playboy's I'm-so-good-I'm-bad personality and natural arrogance instantly added a dimension to the as-yet unidimensional world of holier-than-thou, sanctimonious Superheroes.

A technovator at heart, Stark's experiments and their outcomes were vividly portrayed in movies. Incredible transistors, revolutionary microcircuits, flesh-healing serum - these were just some of his inventions.

Stark's most outstanding piece of work in the Iron Man franchise, however, is the Iron Man suit. This estimated 225 pounds of metal, armor, gadgets and awesomeness is powered by the fictional "arc reactor," which runs on Palladium. In Iron Man 2, Stark creates a mysterious new element to power the suit.

As cockily and aptly quoted by Stark: "Iron Man. That's kind of catchy. It's got a nice ring to it. I mean it's not technically accurate. The suit's a gold titanium alloy, but it's kind of provocative, the imagery anyway."

Vibranium

The mysterious new element - Vibranium - took Stark a couple of days from conceptualization to application.

"In the real world, it can take 20 to 30 years to move a new material from discovery to application," says Suveen Mathaudhu, program manager in the materials science division of the U.S. Army Research Office.

There are four major parts of a discovery in Materials Science -

1) Processing, which is how a material is made.

2) Structure, which is how a material's atoms, molecules and crystals are arranged.

3) Properties, which are how a material behaves (e.g., how strong it is, how elastic it is, etc.).

4) Performance, which is the combination of a material's properties that give the material its overall characteristics in various real-world environments.

The process of investigating these areas never began until after a new material was discovered- till recently. But that's changing for the better. And the Iron Man Suit offers a great example.

In Iron Man 2, Stark begins the process of creating his new element by defining the performance characteristics he's looking for. He then searches for the atomic structure that would give a material the necessary properties.

"Sometimes you gotta run before you can walk"

This sort of reverse engineering is the new model for materials research. For example, a few years ago the Department of Defence was searching for a material that could be used in a new type of landing gear. Materials scientists used the specific characteristics DOD was looking for to reverse engineer a new iron alloy from scratch.

Current Status

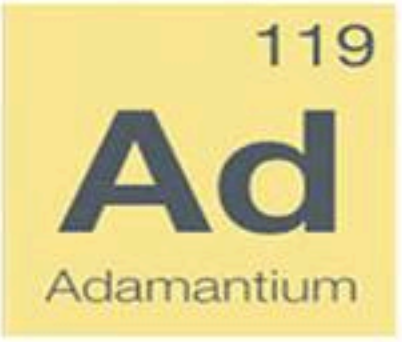
The US military is developing a new Iron Man-style "Tactical Assault Light Operator Suit" (TALOS). The Special Operations Command (SOCOM) of the US military is collaborating with industries, research laboratories and university scientists- including MIT engineers- to develop a special full-body bulletproof exoskeleton that will give soldiers "superhuman strength and greater ballistic protection." The exoskeleton will likely consist of liquid body armour being developed by MIT researchers.

Wolverine Boneclaw

As if his easy arrogance and devilishly good looks were not enough to endear him to the audience, Wolverine got blessed with one of the coolest and most agile weapons of all time - his boneclaw. While as kids we swooned over them, Material scientists now wonder if it's possible to fabricate them! Transcending the barrier between human imagination and reality has hooked the scientists, and driven research into developing a biomaterial which possesses the strength, biocompatibility and durability of Wolverine's boneclaws.

Adamantium

Marvel's X-Men series has ensured that kids today know Adamantium as well as Oxygen or Nitrogen. The name roots from Adamantine, meaning 'invulnerable'. Adamantium is best known for being the substance bonded to the Wolverine's skeleton and bone claws. Researchers want to replicate this material's properties so they can be used as a cutting tool, bone implants and shock absorber.



Is it becoming a reality?

In a journal, MIT researchers described a new adhesive made of protein-infused polymers and ceramic that provided greater strength and stability for bone implants.

The polymers help bone cells form and attach to an implant. Tests were conducted on rats, and the scientists found that it was more likely for the bone to break than for the implant to detach from the bone.

The discovery is great news for people who have had implants of any type. Implanted devices are mostly made of titanium and the polymer adhesive basically makes the body believe that the titanium implants were bone, which has been described as "really good double-sided tape" that happens to contain bone growth proteins. Well, it seems like it's only a matter of time before someone gets Wolverine claws!

Iron that is made up of nanoscale crystals supersedes its traditional counterpart in terms of strength and hardness, but has found limited application practically till now, as its nanocrystalline structure breaks down at relatively modest temperatures. However, North Carolina State University researchers have developed an iron-zirconium alloy that retains its nanocrystalline structures at temperatures above 1,300 degrees Celsius approaching the melting point of iron, which should definitely see the horizons expand as far as use of this technology is concerned.

Spider Man's Webs

The webslinger holds a special place in the heart of every 90's kid, possibly because Spiderman movies were the most popular Superhero movies at one point of time, not to mention the wild popularity its PC games received. Peter Parker's ability to fly across the sky without having to recharge for fuel, and his ingenious use of spider silk for diverse and varied purposes certainly made for a fascinating show! However, while our 'friendly neighbourhood spiderman' zips and swings his way around the city, what really goes on with the spider silk at his disposal?

The most likely material for developing this technology would be a high strength material, given the enormous strength of the material Spidey uses. However, a choice of material on the basis of strength alone does not justify all the cool properties Spiderman's web is shown to have. The unique alignment and confinement of the nanoscale fibrils in spider silk explain the paradoxical strength, toughness and extensibility that we see in what would otherwise be a weak material.

When hazarding a guess at a possible real-life substitute of spider-silk, Carbon Nanotubes is the substance that first springs to mind.

There certainly seems to be a lot of excitement about what awaits some years down the line as far as these materials are concerned. While scientists' primary concern with developing such materials would be biomedical or defence purposes, you never know when a Professor X might tag along, and unleash his own version of this technology upon the world.

Remember people - with great materials, comes great technology! Here's to more such awesome inventions and materials - and of course, to all the Superheroes and their movies for lifting us from the depths of drudgery & tedium! Cheers!

WHY META IS MORE THAN JUST RESEARCH

Darsh completed his Btech in Metallurgy and Materials Science in the year 2012. In his insti life, he was involved in quite a few extracurricular activities: be it Managing competitions at Padarth, working as an Editor for Dhatuki or the General Secretary of Hostel 4. He then went on to work as a Senior Consultant at Monitor Deloitte, Mumbai from 2012 to 2016. Currently, he's in the first year of the MBA program at the Harvard Business School, Boston.

Darsh Maheshwari

After graduation...

I am currently in the MBA program at the Harvard Business School. My focus is to build leadership skills, and get knowledge in marketing and innovation. I joined a consulting firm, Monitor Deloitte, in Mumbai after graduation and worked with them for 4 years before I left for HBS. I joined them partly because they had a lot of manufacturing companies as client, especially in the steel sector. I considered consulting as being a good foundation in how business works. Most of my work was in marketing and growth strategy. As a result, I ended up working across 12 industries over the 4 years.

How a degree in Meta @IITB has been helpful

Two things stand out for me from my meta experience. First, doing a research project (which eventually became my BTP) with Prof. Bhargava. I was always interested in body armour (bullet proof vests), and started my research by analyzing ceramic body armour. I also slip casted alumina body armour. In addition to the intellectual satisfaction of seeing engineering in practice, it built a lot of patience in me.

Second, two courses in the final year - iron and steel making, and industrial process design gave me a very good idea of what manufacturing setups are like. They were helpful in my consulting career since I did a lot of work in heavy industry and manufacturing.

Meta is a very supportive department. Most students start the program with a lot of cynicism towards the benefits that they will get out of the program. People should not - do it in the right spirit and you will get a lot of value out of it.

Advice for current students

Be patient. You have a 50 year career ahead of you - when choosing courses, departments, and internships follow your interest (even if that means being paid less, taking risks, giving up lucrative jobs, or doing something that is not glamorous). You will be rewarded a lot more in the long run.

Focus on doing a few things and do them well. Don't try & do everything - choose 2 things that you like and master them. Academics are very important. Take it very seriously. Grades matter a lot, and will follow you all your life. Even if you find yourself not being interested in subject matter think of it as mental training and do it well. Build strong relationships with professors. They are a lot more savvy than you think and can be great at giving advice.

Dear readers,
We are glad to put forth this year's edition of our department newsletter-Dhatuki, which has been reinstated after a six year long hiatus. This time around, we have tried to answer some significant questions like "What after graduation?" and have discussed entrepreneurship in meta as well, making our students aware of the multitude of opportunities that lay before them. We have highlighted pertinent issues like what new developments have been planned in the department. Words of wisdom from our alumni would help you in your endeavours. Finally for the enthusiastic ones, we've come up with a leisure piece on superhero materials science.
Cheers!
Kewal Bhat and Pallavi Verma

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