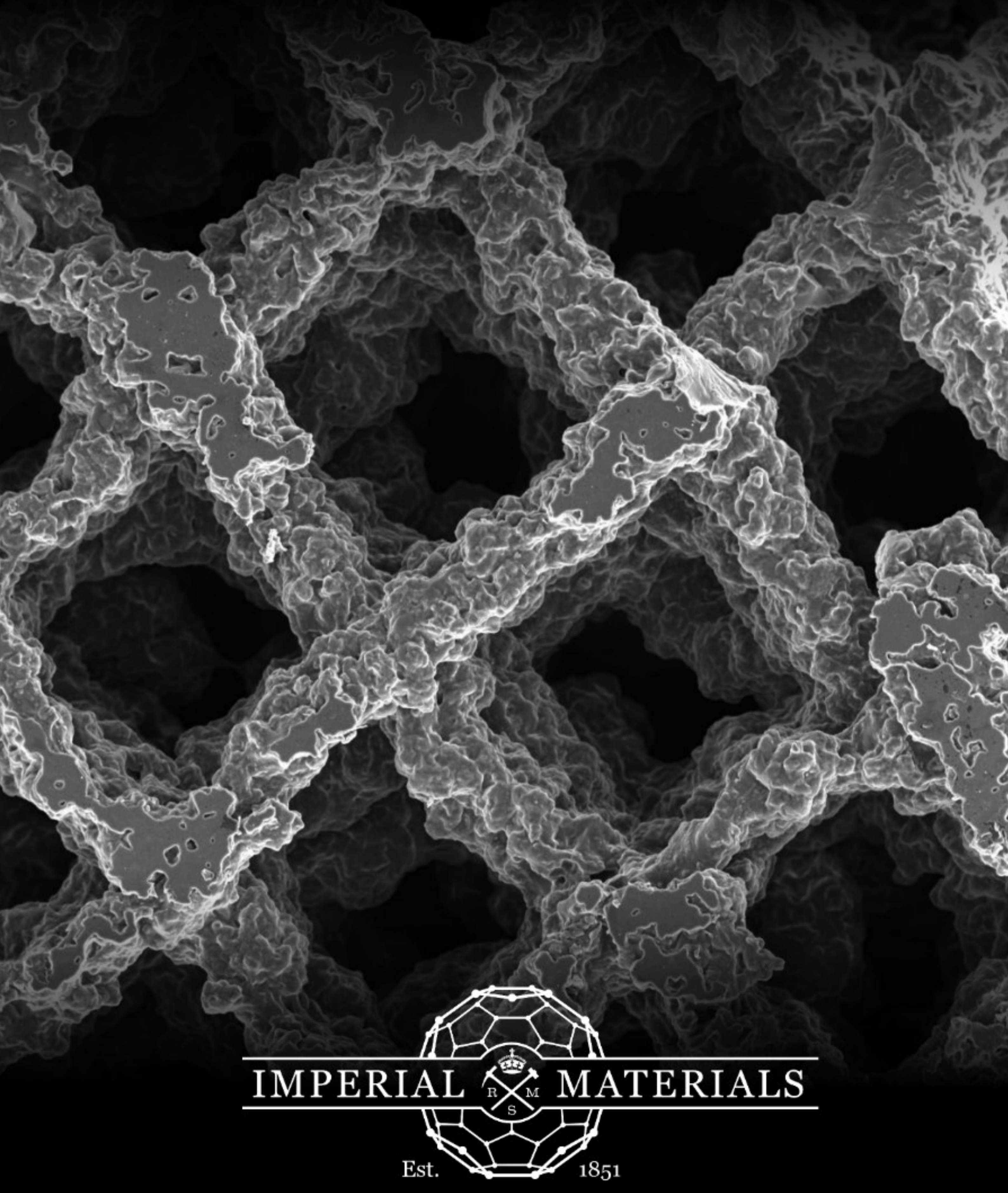
MatSocMagazine

Summer 2019/20



IMPERIAL MATERIALS

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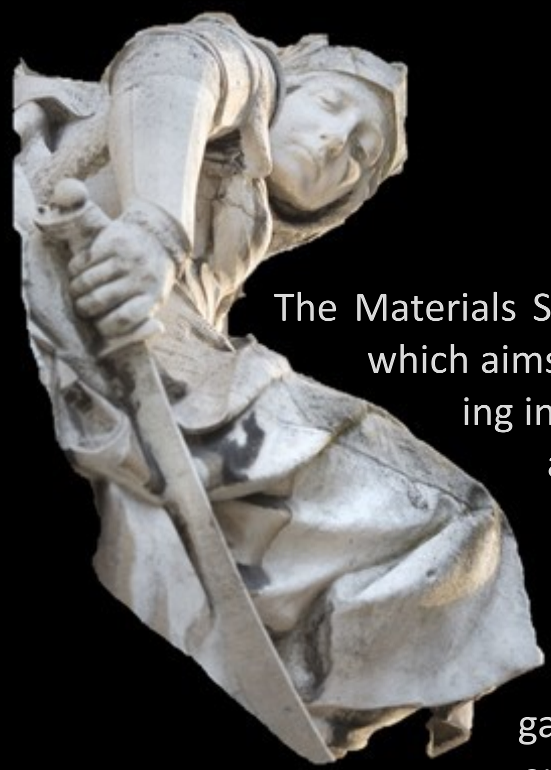
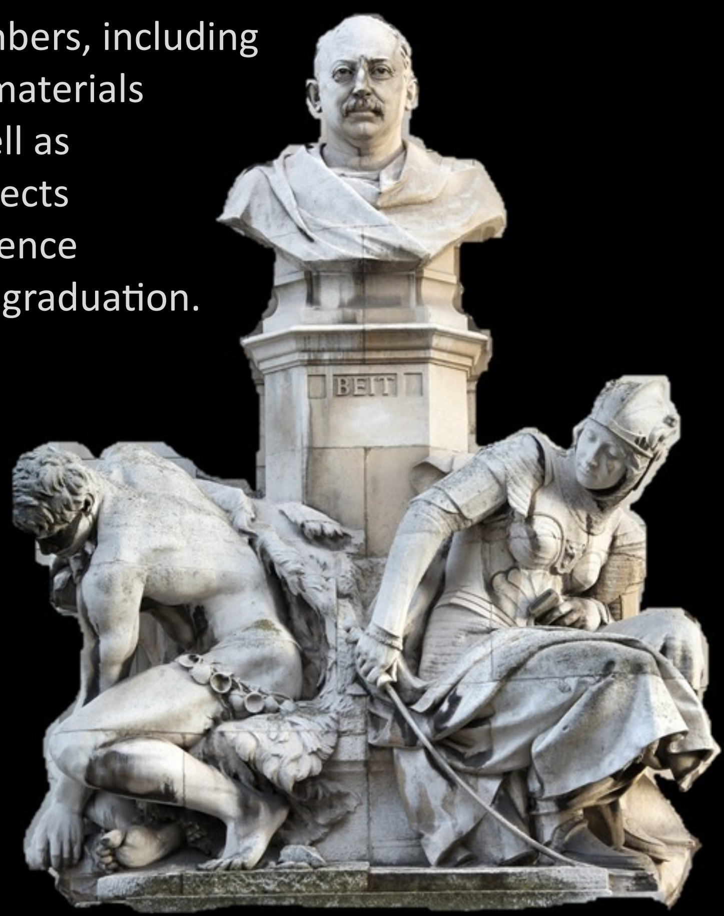


The Materials Society (MatSoc) is a student run organisation which aims to enhance the experience of students studying in this department at Imperial College London, and to promote Materials Science and Engineering both at university and in industry. We achieve this goal through collaborative events, social functions, extra-curricular lecture series, and industrial visits to engage with materials science beyond an academic environment.

Our society currently has 762 members, including undergraduate and postgraduate materials science students at Imperial, as well as other students studying other subjects who are interested in materials science and working in related areas upon graduation.



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FROM THE EDITOR'S DESK

Hello and welcome to the final edition of the MatSoc magazine for the 2019-20 academic year!

I am particularly proud to present this edition of the magazine that has contributions from the students, alumni as well as staff. With the unexpected turn of events at the end of the year, the perseverance to strive for the best even under adverse circumstances was the highlight in everyone around us. Ranging from reports on the MatSoc trip to Diamond Harbour and the Bauermann lecture, to reminiscing pre coronavirus times, to importance of mental health awareness in trying times and from staff about their efforts to maintain standards in education even with the challenges in remote learning, this edition covers a real array of topics, perhaps reflective of our diverse community.

While I finish off this edition in my pyjamas at home, quite unexpectedly, far from college and drastically different from what I had originally envisaged, I'd like to wish everyone the best of health and hope everyone remains just as excited as me about the prospects of the next academic year. I am also pleased to introduce **Aishwarya Varanasi** as your next editor and I hope she finds the experience as enjoyable as I have.

As always, please feel free to contact the writers or myself for any comments about the articles.

It's been *alloy* a pleasure,

Disha Bandyopadhyay

MatSoc Magazine Officer 2019/20

ARINJAY

GEORGE

MARCUS

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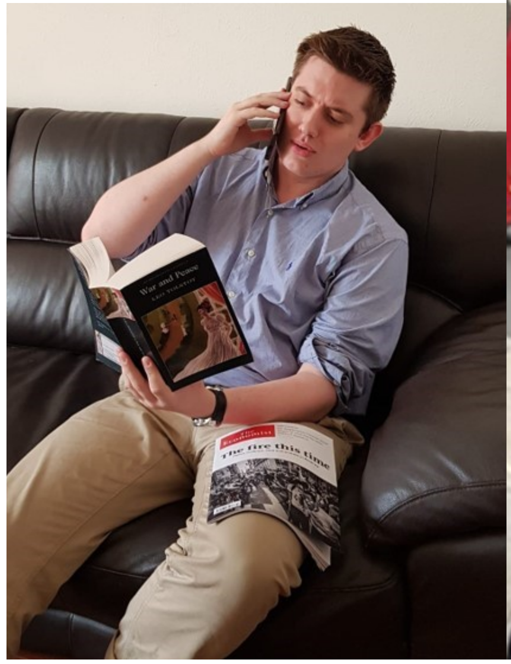
POOJA

CHARLIE



ADAM

ALISHA

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MUCH ADO ABOUT 1ST YEAR:

A WELLBEING REVIEW

Emily Li, 1st year wellbeing representative discusses the wellbeing events she organised that brought together her cohort.

A pang of hollow nostalgia trickled into existence as the image of 96 bright, smiling faces was filed away with our 50th and final weekly report of Undergraduate Year 1. Despite the enticing prospects of summertime fun, a wave of reluctance of letting go washed over, as if yet another quarantine series we've binged and loved fizzled to a conclusion.

However unconventional last term may have been, the utter devotion and limitless creativity of our lecturers let us complete the year on a satisfying end. Past disruptions and distress the pandemic has caused, much reflection has reminded me of the time together we'd taken for granted. With a grateful heart, I put fingers to keyboard, driven to appreciate those memories I so much cherish.

Via Elizaveta Mihaqlova Belocerkovec

We met in the stuffy, bustling room of G01, with a lingering smell of pizza afloat in the air. Anxious, but excited for what our new journey would bring, we tirelessly chattered away. Handshakes, smiles, and friendly moments later, the fervour of the students melted what little ice was between us—already bonding over the iconic red heads of Priya and Dom; eagerly strategising for the Materials Challenge presented to us. With that, an extraordinary year kicked off to a start.

Before we knew it, holiday season rolled over, and the much-awaited Christmas was right around the corner. Just about getting to grips with the role of Wellbeing Rep, I thought it'd be the perfect time to debut with a cohort-wide event: Secret Santa. With the support of friends and our other reps, the date was set, matches made, and only the anticipation for end of term was left. When the day came, oh, was it a pleasant surprise. Tears were shed, and laughter rang, as presents, questionably shaped and ridiculously sized, flocked into the Common Room, torn apart, and revealed. First term ended on a hearty tone, filled with the fragrance of chocolate chip cookies, and the joy of Christmas.

Needless to say, with the vast diversity of our community, many more celebrations of heritage were to come. The insurmountable respect for each other's cultures, and willingness to learn more was especially moving to see. On a not-so-typical Friday afternoon, the dim room for Design Study lit up with the final few minutes of livestream of the Spring Festival Gala. We sang and clapped together for the countdown to Chinese New Year, some of us 8000 km from home.

The familiar sound of boiling water permeated the room, as endearingly misshaped dumplings bobbed inside of pots. Regardless of skill, everyone was keen to have a try at one another's traditions.

Soon, the talented performers of our year were ready to show the fruits of their practice, the rest of us just as eager to watch. Tens of us filed into the packed doors of the Great Hall, anticipating what turned out to be an amazing show: Malaysian Night. We cheered for our friends as they executed immaculate moves in Dikir Barat, and of course, when one appeared in a 3 second cameo even without any dialogue. A week later, we prepped to attend the long-awaited East Meets West, but were unfortunately interrupted with the regulatio-ns of lockdown. This did not stop us, however, from supp-orting our brilliant dancers, as we admired the streaks of red and white prance across the screen in the comfort of our homes.

Though geographically we may have been apart, we still remained very much connected.

Houseparty games, Virtual Common Room serenades, study support on Teams...We worked actively in unity despite all that went on. Ending the year on a high, we even got to witness the bringing home of a talent show win, accredited to the phenomenal performance our classmates produced.

Of course, a reflection of this year is incomplete without the mentioning of Dress-up Dewen Day. Of our own volition, we coordinated a cohort-wide formal dress code, just to poke fun at the eternally-suited Dewen, who turned up in nothing but a goofy, pink dress. Talk about extra, but they're things like these that brought us together—once again, reminding us that apart from academics, there was always room for light-hearted banter.

Musing over the joys of first year, I can't help but smile. I am truly grateful to have met such an incredible group of people. Perhaps it's the amicable size that strengthened the cohesion of our cohort, but I can say with confidence that this department has really become an extension of home. The future is a spontaneous mass of the unknown, and I cannot wait to see how we shape it.

MATSOC TRIP:

DIAMOND LIGHT SOURCE SYNCHROTRON

Olga Enikeeva, 2nd year undergraduate, reports on MatSoc's trip to Diamond Light Source

On March 4th, a small group of Materials students visited the Diamond Light Source Synchrotron located at the Harwell Science and Innovation Campus in Didcot. After a long coach ride and an impromptu 20-minute tour of Diamond's immediate surroundings as we tried to find the correct entrance (enjoyed the fresh air, somewhat less so that the air was around 2°C), we signed in and were ushered into a small lecture theatre where the inner workings of Diamond were explained to us.

Essentially, electrons are accelerated to near-light speeds as they pass through tubes with alternating electric charges, after which they pass into a booster synchrotron and then a larger storage "ring" that is actually a polygon composed of 50 straight sections. The electrons driven around the corners of the synchrotron using powerful bending magnets. When this bending occurs, electrons lose energy that is emitted as electromagnetic radiation, that is then channeled into straight sections leading off the storage ring. These straight sections are known as beamlines, and several of these contain insertion devices, which are magnet arrays that cause electrons to follow a zig-zag path, thus giving off more radiation and producing even more powerful light. This set-up is used to produce light many billion times brighter than the Sun, and the resulting EM radiation (typically in the range from infra-red light to X-rays) is used to analyse samples at extremely high magnifications, often at the scale of individual atoms.

These experiments take place in the beamlines that are composed of a cabin where the light is focused and filtered to the wavelength required for the specific experiment, the experimental area, and a control cabin. The experimental areas are typically automated to varying degrees, so that in many cases the sample can be adjusted using robotic arms without entering the irradiated cabin. We were informed that Diamond accepts a wide range of research topics, including but not limited to drug research, materials, electronics, and so on. The only 2 things that Diamond does not analyse are live samples (as they would quickly cease to be so after being bombarded by radiation), and research directly relating to military applications (if the same reasoning applies, presumably because military research also tends to lead to unexpectedly shortening the lifespan of currently alive things).

90% of research conducted in the Diamond synchrotron is free for the users, and is the general path chosen by researchers. To be eligible you need to submit a proposal that is reviewed by an independent panel once every few months, and also to agree to make your research freely available to the public after the project's completion. The faster path (that is the remaining 10% of Diamond's use) is the avenue typically chosen by companies, as while you have to pay for the synchrotron's use, you are not subject to the same rigorous review process, nor are you obligated to disclose your research. For companies where time-to-market and competition are important factors affecting their profits, it is understandable why they may elect to pay instead of taking the free, but longer route.

Following this info session, we received our guided tour of the synchrotron. The control room located at the main entrance of the synchrotron displayed all the statistics relating to Diamond's functionality, monitored 24/7 by dedicated staff members. We then took a few laps of the synchrotron – first so that it was directly under our feet (helpfully separated from us by several metres of concrete), and then around the structure so that we could see the beamlines from the side. Unfortunately, most of the beamlines were in use (and thus filled with radiation), so we did not get a chance to enter and look around (though a few of the cabins had windows). One of the sections leading off a beamline that was pointed out to

us was used for analyzing large full-scale objects like motorcycles or turbine blades, unlike many of the other cabins that were designed to hold relatively small samples (around micron sized).

One other interesting tidbit was a cabin not connected to a beamline at all. This was a relatively new construction used to test out the set up for one of the beamline-connected cabins that was typically used for biological samples. That particular beamline was less automated as samples tended to vary in dimensions, leading to the one-size-fits-all approach being less useful. The testing cabin was therefore so that researchers could take some time to work out how to fit the sample without cutting into their limited time allocation.

All in all, Diamond Light Source is probably one of the more massively sophisticated microscopes you're ever going to see (and they are planning more functionality upgrades in the coming years, which probably means bigger and better magnets and more insertion devices), so if you ever find yourself with a free day, or for some reason need a stupidly powerful microscope, or want to get lunch that is a lot better than college food, do pay them a visit.

UNDERCOVER AT IMPERIAL:

G20 ROYALE

Inspired by The Cambridge Tab, MatSoc collaborated with Lucia De Angelo, an arts student from London College of Fashion to evaluate a lecture at Imperial.

There's always been this clear division between sciences and arts for me. I have always wondered how they are different from one another in the context of the education system. How differently are they taught? I took attended a Material Science lecture to understand the differences, and also learn some science in the process!

Hi, my name is Lucia. I am a third-year student at London College of Fashion and in February 2020, I had the opportunity to attend a second year materials lecture by Professor David Dye.
During my visit I also had the opportunity to visit the lecture rooms, the common room and some labs and get all my questions about the life of a Material Science student answered.

> "I have always been curious of what it would have been like **if I attended a university like Imperial**."

I come from a family who has never studied arts. Both my parents and their siblings have degrees in either Science, Engineering or Law, so I'm no stranger to scientific and technical conversations. And thanks to these conversations I have a decent understanding of this side of the educational spectrum.

But I've never been part of it myself: I attended a High School of the Arts and I am currently at the end of a BA course in Fashion Media Criticism. After debating to either follow my family's history or to be the first one to diversify from the family tree, and ultimately deciding to do the latter, I have always been curious of what it would have been like if I attended a university like Imperial. So, when the opportunity to attend a lecture came, I said yes immediately!

> "much more **"serious"** and **scholastic**"

From the first step I've set in the Royal School of Mines building I've noticed how much more "serious" and scholastic the university is compared to mine. No giant posters, no mannequins or bright colours, no students dressed in Balenciaga Spring/ Summer 2020. I entered the building while wearing my multicolor ski jacket, already feeling out of place. I must've looked like a tourist with my curious eyes searching for the set of Kingsmen (which I did find eventually: G20, the room where the lecture took place!).

The lecture was very nice, even though I wouldn't be able to explain exactly what it was about, to be completely honest here. The only specific thing I remember from it is that water has no shear force. The lecturer, Professor Dye was nice and his explanations were very easy to follow. He seemed very passionate about his own practice, and it transpired from the way he tried to engage with the students to keep them interested.

The lectures from my course are quite different. We are a class of 12 people, so we don't really use a lecture space but instead we use what could be described as a workshop room with big round tables to which we all sit around, including the lecturer. The lecturer, who often is the course leader himself, often stops the explanations to create discussion points and initiate exercises that we then do either alone or in small groups. Most of our course is practical which means we usually have to attend class twice a week, while developing our projects on our own the other days.

We don't have exams, everything we do is either project or essay based, and we only get around four or five grades per year.

Having had this experience to sit through a lecture made me appreciate and learn these differences between the two fields of arts and sciences. And while I know I made the right decision to go into arts, I am now even more appreciative of the efforts and hard work of the scientific community.

COVID 19:

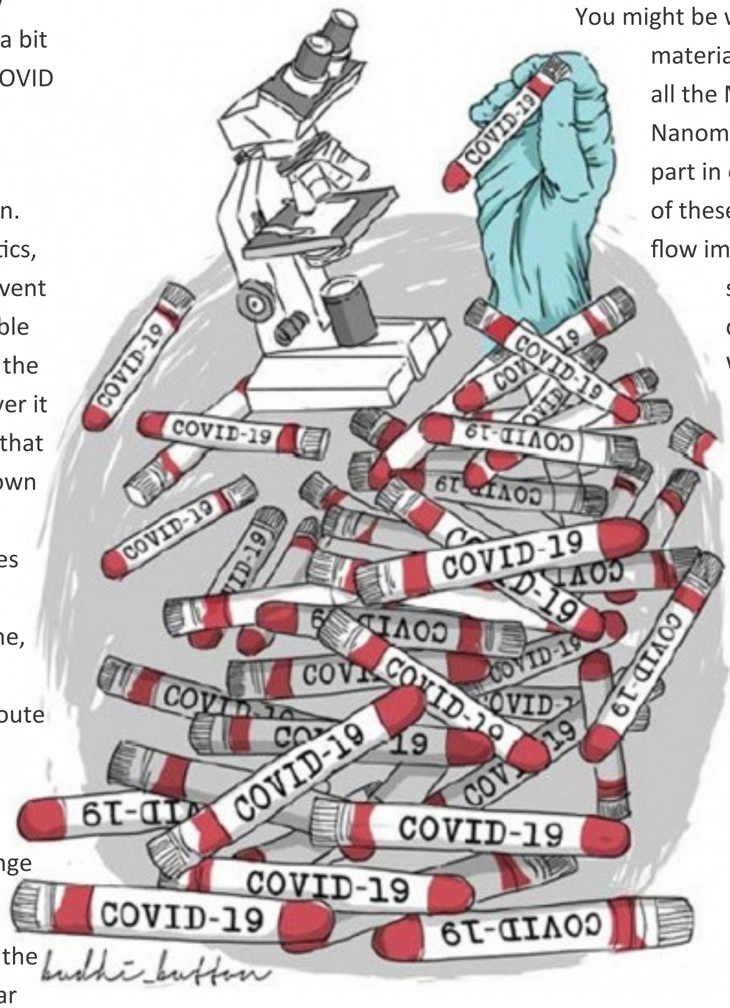
HOW MATERIALS SCIENCE CAN HELP

Schan Christopher Perera, 4th year undergraduate, explains how diagnostics can be improved with materials science.

As we approach the half-way mark of the year, there's no denying that 2020 so far has been one for the history books. In particular, the outbreak of COVID-19 has made the whole world realise, just how much of a threat highly infectious diseases are. As Material scientists you might, like me, be wondering what we can do to help. To the best of my knowledge viral infections cannot be plotted on a phase diagram, so while the lever rule has got us out of a fair few scrapes in the past, we'll have to be a bit more inventive in the fight against COVID -19.

When faced with any sort of disease there are two routes we can go down. The first of which involves therapeutics, i.e actively subduing the virus to prevent further infection. Obviously, being able to eradicate the thing that's causing the problem is the ideal scenario, however it has become apparent that the virus that causes COVID-19 isn't going to go down that easily. While there is a lot of research going on to develop vaccines and anti-virals, it's important to remember that these things take time, possibly even years to be proven effective. This is where the second route comes in: diagnostics!

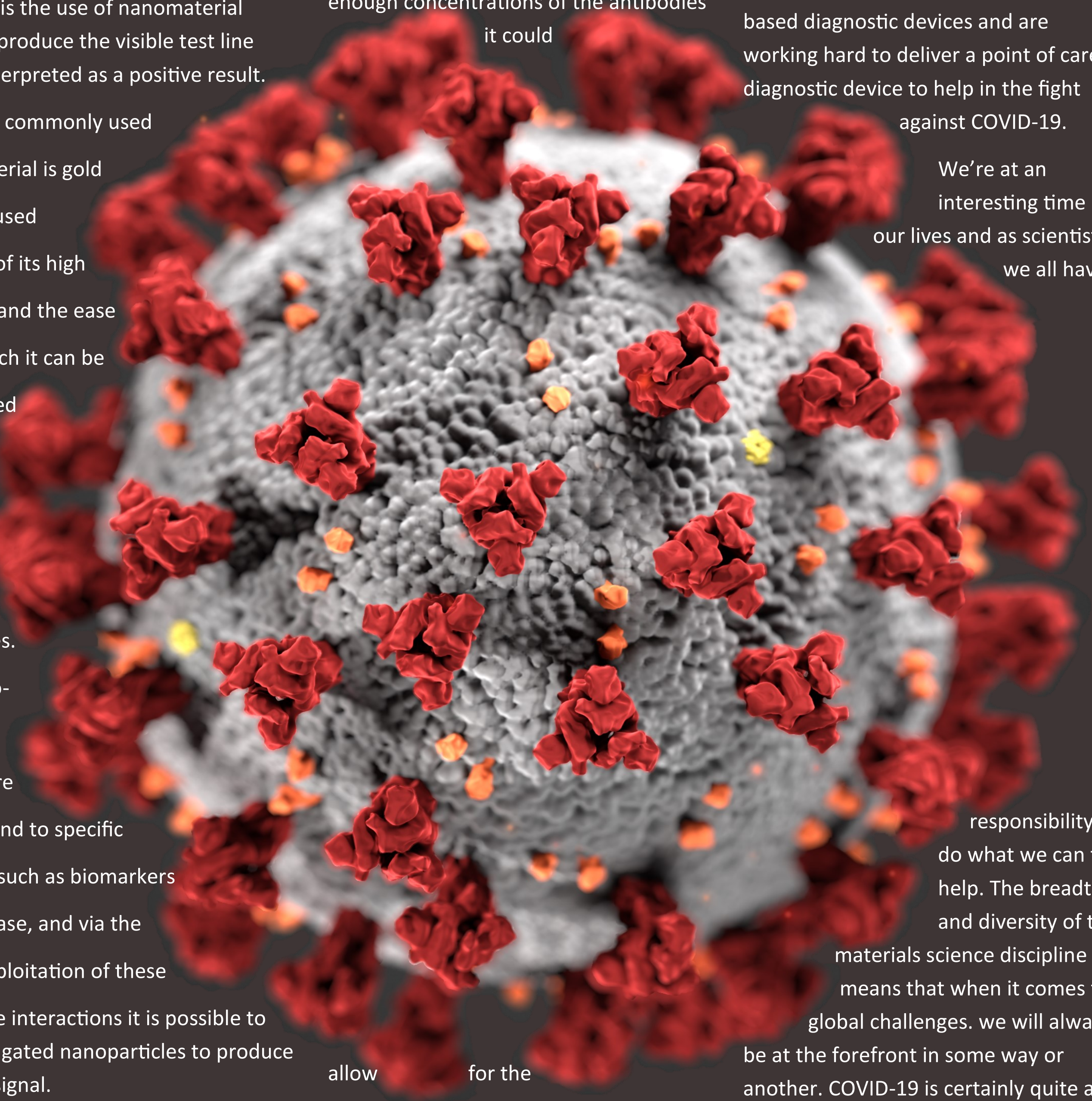
The highly infectious nature of COVID-19 presents a massive challenge for scientists and governments trying to keep up with the spread of the disease. The most common molecular based test, PCR (polymerase chain reaction), uses viral genetic material as a marker for disease, allowing for a highly sensitive and specific diagnosis. While being the gold standard for virus detection, PCR has the drawbacks of being expensive, time consuming and resource dependent. These drawbacks are the main reasons why we are always one step behind the virus, making it incredibly difficult to stop it from spreading.



Via: *https://www.thejakartapost.com/academia/2020/04/29/mapping-of-laboratories-urgent-for-mass-covid-19-testing.html*

As of writing this, COVID-19 has been confirmed in 213 countries, so it's safe to say that any diagnostic test that is developed needs to be highly scalable so as to reach every corner of the world. During the HIV outbreak, the WHO outlined a set of criteria (see below) for the design of so called 'point-of-care (POC)' devices to bring together the wealth of research that up until then had been relatively incoherent.

You might be wondering where the materials science is, this is after all the MatSoc magazine. Nanomaterials play an important part in one of the most promising of these POC devices: the lateral flow immunoassay, a device that satisfies many of the criteria outlined by the WHO.



The most famous example of a lateral flow immunoassay is the pregnancy test, providing an easy to use, affordable assay that gives the user a result in minutes. This platform is extremely versatile and has the potential to be applied to detecting a range of diseases. One thing these devices all have in common is the use of nanomaterial labels to produce the visible test line that is interpreted as a positive result.

The most commonly used nanomaterial is gold which is used because of its high stability and the ease with which it can be conjugated to bio-sensing ligands such as antibodies. These bio-sensing ligands are able to bind to specific antigens such as biomarkers of a disease, and via the clever exploitation of these nanoscale interactions it is possible to use conjugated nanoparticles to produce a visible signal.

So, what if we could develop such a lateral flow immunoassay for the detection of COVID-19?

This would be amazing but unfortunately the detection of active viruses themselves, presents a whole new range of challenges, especially when considering the translation to a scalable lateral flow device. The next best thing, however, would be to design an assay that is able to detect the antibodies that the body produces in response to the virus. Such a device is multi-purpose. Firstly, if the device can detect low enough concentrations of the antibodies it could allow for the disease to be detected at a much earlier stage, before symptoms start to show. This gives us valuable time to help isolate those at risk and prevent the spread of the disease while allowing for treatment to start earlier. A second purpose is to help identify asymptomatic carriers who might have antibodies against COVID-19 without even realising they had it.

Excitingly, our Department is one of the research hubs aiming to develop such a test. Professor Molly Stevens and her team of researchers are experts in the design of ultrasensitive, nanomaterial based diagnostic devices and are working hard to deliver a point of care diagnostic device to help in the fight against COVID-19.

We're at an interesting time in our lives and as scientists we all have a responsibility to do what we can to help. The breadth and diversity of the materials science discipline means that when it comes to global challenges. we will always be at the forefront in some way or another. COVID-19 is certainly quite a large challenge, but one that we will undoubtedly get through with a little bit of help from nanomaterials.

Illustration via Alissa Eckert, MS; Dan Higgins, MAMS

BAUERMAN PRIZE LECTURE 2020:

NEW MATERIALS FOR NEW AGE, MULTIFERROICS MARCH ON

Aishwarya Varanasi, 2nd year reports on the annual Bauerman prize lecture

This year, the annual Bauerman lecture was delivered by Professor Nicola A. Spaldin who is a Professor of Materials Theory at ETH Zurich. She is an exceptional researcher who defined her own field of research, ‘multiferroics’. Behind this daunting name, lies hope of a new technological era. We are currently facing a paradigm shift in materials engineering with regards to the increasing speed of computers. It is believed that if we don’t change tech-nologies, by 2030 they will swallow 50% of global energies. Prof. Spaldin begins the lecture by highlighting the fact that new materials have been the key to creating new technologies from the dawn of knowledge.

“We are currently facing a paradigm shift in materials engineering”

She proposes multiferroics as candidates for further miniaturization of devices as they have the potential to replace Silicon in integrated circuits.

“It’s a pity that there are no ferroelectric magnets”- Prof. Nicola A. Spaldin’s colleague

A casual observation made by a colleague led to a driving question for Prof. Spaldin’s career. Prof. Spaldin, a young Post – Doctoral Research Associate (PDRA) back then, specialized in ferromagnets in a group that worked on ferroelectrics. The question of why there are no magnetic ferroelectrics became an “obsession” for her. After investigating this topic, she designed a new class of materials called “multiferroics”. These are materials that are simultaneously ferroelectric and ferromagnetic.

Now, what are ferroelectrics and ferromagnets?

We are all familiar with magnets, materials that possess spontaneous magnetization due to the presence of magnetic dipoles. If these dipoles all align in the same direction this is ferromagnetic ordering, and the direction of the dipoles can be changed by applying an external magnetic field. Similar behaviour can also be observed with ferroelectrics, which possess spontaneous electric polarization that can be reversed by electric field.

“Choose an interesting question and go after it with gusto”

Prof. Spaldin has revolutionized the very fundamentals of physics by making materials that are both ferromagnetic and also have an electric dipole moment. These materials have both a positive and negative charge (ferroelectric). The fact that ferromagnetism and ferroelectricity don’t coexist (i.e. the kind of elements that make good magnetic materials are a different set from the kind of elements that make good ferroelectric materials) makes making multiferroics an “interesting” research question. From a technological point of view, this is very appealing because using an electric field to control magnetic properties saves energy (i.e. making a magnetic field needs a big coil of wire carrying current, while a couple of tiny electrodes would be sufficient to create an electric field).

“New materials have been the key to creating new technologies from the dawn of knowledge”

“There could be a breakthrough tomorrow or never”

By using calculations and simulations to design materials that combine more than one function, Prof. Spaldin discusses two different possible routes for generating magnetoelectric multiferroicity in materials. The first approach being combining elements that have good electrical properties with elements that have good magnetic properties. The second approach uses unconventional synthesis mechanisms. She acknowledges the fact that what we still miss is a material that is both a good ferromagnet and a good ferroelectric at room temperature (as most electronics function at room temperature).

“Universe’s existence may be explained by a new material: such as this astronaut seen above the Earth!”

My favourite part of the lecture was when Prof. Spaldin said that she didn’t want to give an impression of how she thought the research that she did was useful. She finished her talk with an example of multiferroic research that wasn’t very useful but fun. She discussed how her mathematical models of what happens when multiferroic materials transition into different states – much like water turning to ice – turn out to mirror some cosmologists’ models for how the universe behaved in its early formation (the so – called grand unification transition).

Along with cool graphics of yttrium manganate multiferroics and computer simulations of strings, I felt that this lecture was an inspiring reminder of how by pursuing fundamental science there can be great strides in technology. Simulations of new materials allow us to investigate materials in a way never done before, allowing us to bring about faster, better and more energy efficient materials. However, as much as I learnt that ‘multiferroics have the potential to replace Silicon in integrated circuits, I believe that the take home message from the Bauerman Lecture would be **"Do what you're passionate about. It may not be the easiest choice, but it will be the most rewarding."**

REMOTE REALITY 1:

AGE OF CORONAVIRUS

Yash Dwivedi, 1st year undergraduate, thanks staff

"From Monday 16th March, we will be delivering all teaching remotely..." were the dreaded words I read in the email from the president during my rehearsal for EMW: a cultural show hosted by Indian Society, that was scheduled to premiere in 2 days' time but was inevitably cancelled. The second term of our first year studying Materials came to an abrupt end, one week earlier than planned. No longer were we going to experience the third term conventionally. A big question mark presented itself for what the rest of the academic year would look like, though the main concern on most people's minds was to contact families and get home safe.

Saddened by the news, but still willing to make the last few days memorable, we had a final gathering with course mates and managed to enjoy the last night before we all, unavoidably, had to leave. I reluctantly packed my belongings and moved out of Woodward the following day, still uncertain of what the future held.

Perhaps it was how closely-knit our cohort was, or maybe it was the strong bonds made with certain people, but I couldn't help but feel low-spirited on the train journey back home. Materials really was a course where we got to know everyone more than just a simple "hi". It was almost a second family.

The premature transition back to life at home felt unusual for the first few days. Many of us were still getting to grips the gravity of the situation. Never had I, personally, thought that circumstances like this would ever arise. As schools, shops and large venues closed, the gloomy reality of the situation finally settled in. A few days later, the long-awaited email finally appeared in our inboxes: Remote Assessments. It was time to hit the books, pull out the ol' pen and paper and prepare for the exams in a month. As time passed, stagnant days melted into stagnant weeks, with the occasional catchup on Houseparty and Teams being a breath of fresh air away from revision (and procrastination).

I'd be lying if I said April was completely dull. I welcomed the opportunity to get back into running, which has always been an escape for me. I also particularly enjoyed Design Study; a very controversial opinion.

By the first week of May, I believe we had all become accustomed to lockdown life. What kept us going was the curiosity of what remote learning would have in store for us. And of course, we weren't disappointed.

Thank you to Prof Andrew Horsfield for meticulously preplanning and uploading lectures on to panopto, which allowed the Differential Equations course to be a breeze. I think we all loved Dr Jonathan Rackham's wit and charisma in and out of lectures, notably in lecture slides, where his punning ability never failed to impress. Furthermore, I think we all appreciated Prof David Dye's shear commitment to providing a full set of comprehensive and detailed Steels notes paired with his professionally edited, high quality lecture videos.

In terms of remote labs, I think we all owe a huge thank you to the GTAs who helped make concepts clear, even though communication over Teams was stressful at times. Thank you to Dr Eleonora D'Elia and Dr Paul Franklyn for coming up with the rheology extravaganza which we all very much enjoyed (although it led to very questionable slime samples being produced).

This may not have been a conventional term, but it was quite the experience, nonetheless.

As always, there are things to learn from this experience. One of them being to cherish moments with others. More often than not, we take the time spent with others for granted, not realising life's ability to prevent these moments from happening again.

Secondly, expect the unexpected! Many people will relate to this as the world is becoming a seemingly more questionable place day by day. 2020 hasn't been the greatest of years, but one thing I've learnt is to try and live in the present, no matter how inviting the future may seem.

Maybe you've picked up a new hobby, or continued an old one, or maybe you've devoted this time to relax from the bustling activities of everyday life. Either way, the last few months have been a rollercoaster of events and I'm sure I speak on everyone's behalf when I say I hope the future offers a fresh new start to what we know as normal life.

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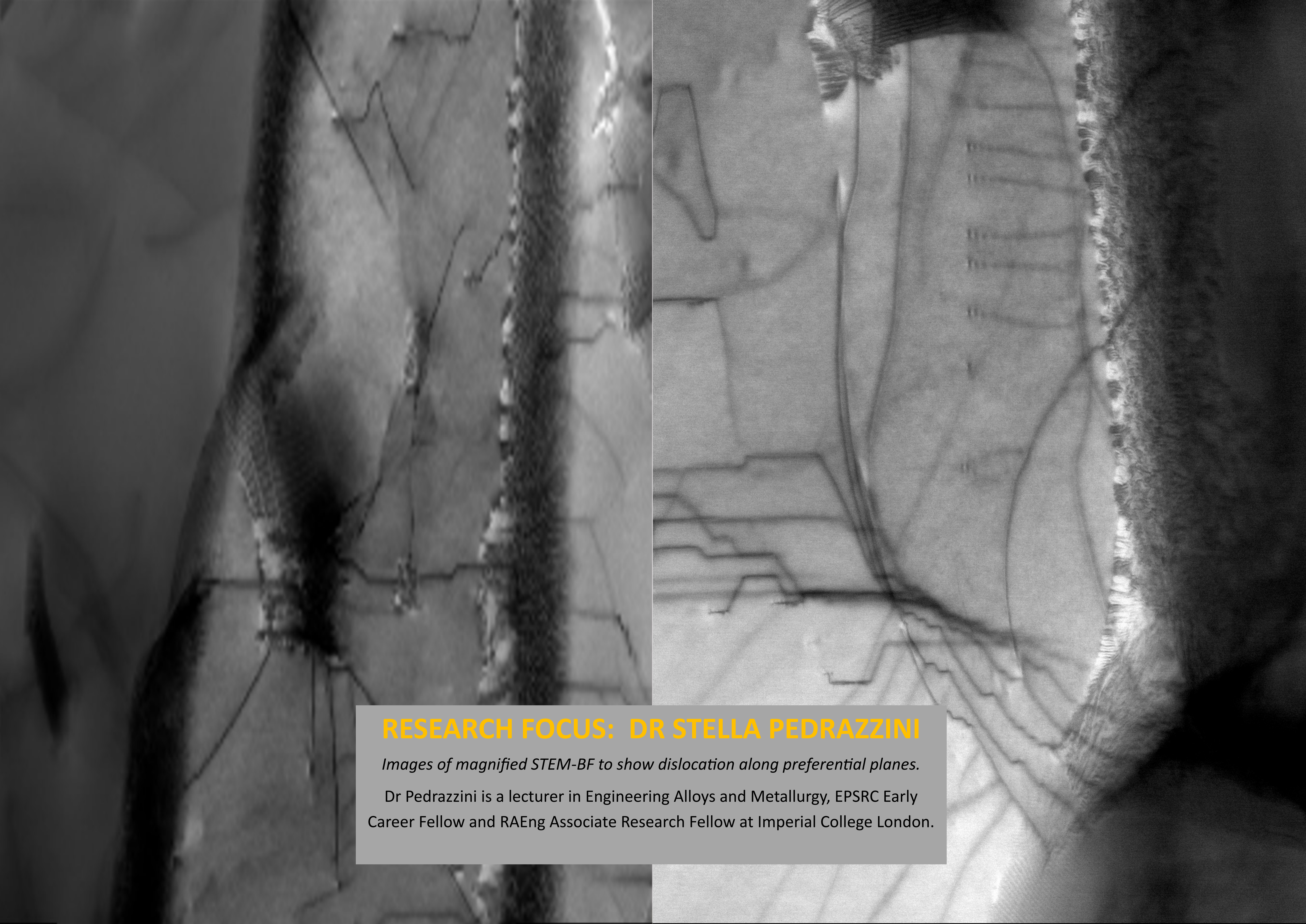

RESEARCH FOCUS: DR STELLA PEDRAZZINI

Images of magnified STEM-BF to show dislocation along preferential planes.

Dr Pedrazzini is a lecturer in Engineering Alloys and Metallurgy, EPSRC Early Career Fellow and RAEng Associate Research Fellow at Imperial College London.

RESONATING WITH RESEARCH:

DR PETROV AND THE MICROWAVE TUNABLE DEVICES

Disha Bandyopadhyay, 2nd year undergraduate, spends an afternoon with Dr Petrov Petrov

If you haven't been lectured by Dr Petrov about plasma or thin films, you've surely met him as the health and safety officer in the first-year induction. He joined Imperial in 2007 after working in various projects in not just UK but also in Russia and Sweden.

I myself became charged by his second year 4-part lecture course on plasma and so I trekked all the way to Bessemer to find out more. I interviewed Dr Petrov about his past projects and current research. In the meeting, we discussed the advantages of collaboration in research, negative capacitance, his first ever project with tuneable devices, encryption, as well as the radio clock in his office (that doesn't always receive signal from the national atomic clock due to interference with signals from the nearby TFT lab)! The four key takeaways from our iconic conversation are as follows:

1. **Science is constantly developing and changing.** In fact, the content taught by Dr Petrov in his lectures now wasn't available when he was an undergraduate student. In this world of rapid discovery, the important thing is to assimilate the fundamentals to be able to continuously improve science. Science and technicalities get updated but the fundamentals stay the same.

2. **It is important to stay open minded and flexible to new ideas and opportunities.** Surprising considering how Dr Petrov's recent research has been experimental, his masters was in modelling and it focused on theoretical experimentation. Dr Petrov then went on to do an internship where the demands required an actual product rather than simulations. That is how he worked on his first device – ferroelectric thin films in combination with high temperature superconductors for telecommunications.

"worked with **many researchers from other Departments across the College**"

3. **Successful projects take place by effective collaboration.** Dr Petrov describes his research pursuits as problem solving. He has been involved in a wide variety of fields in his research. These feats include electronic devices like TFBAR (Thin Film Bulk Acoustic Resonator), fluorescence enhancement for biomedical applications as well as surface profilometry techniques to study extensive resorption of dentine disks in cultures from patients with acute Charcot osteoarthropathy.

For the project with Charcot osteoarthropathy, the medical research team approached him with a materials-related issue of figuring out how to study the use of synthetic bone substitutes in these patients. Once he was able to solve this, he signposted the research team to Prof Eduardo Saiz in our department to work on solutions with bioceramics. Similarly, he has also worked with many researchers from other Departments across the College and their continuous collaboration helps them find solutions to problems from their different research outcomes.

4. **Research is a journey and what may be considered wasteful by-products of some research are in fact breakthroughs for others.** A lingering problem from some of Dr Petrov's previous research was interfering radio frequency (RF) signals in telecommunication devices. Acoustic waves were taking up unnecessary power and needed to be eliminated for fabrication of low loss tuneable microwave capacitors. Having identified this issue, in his next project, the undesired generation of acoustic waves was utilised to develop new class devices: microwave TFBARs with electrical tuning of the resonance frequency. Thus, a problem was turned into a novel and ground-breaking solution.

The hour spent with Dr Petrov was invaluable learning. The conversation was inspiring where I learnt about current research that our department is involved in. It was exciting to find out the behind-the-scene work that goes on from lab to real life applications. I thank Dr Petrov for his time to answer my questions and I would request every student to encourage curiosity and engage with their lecturers and broaden their horizons on learning outside the confines of G01 and G20!

Image via: Thomas Angus, Imperial College London

IMPERIAL MATERIALS Est. 1851

SILICON IN WATCHES:

TECHNOLOGICAL MARVEL OR NEW AGE FAD?

Benjamin Nicholas, alumni, discusses materials selection in watches

The watchmaking industry has never been one to rest on its laurels; the never-ending quest for accurate timekeeping pushes watchmakers to constantly innovate and refine their movements to stay ahead of the competition: complications such as the tourbillon and carrousel aimed to negate the force of gravity on the balance wheel of a pocket watch; the coaxial escapement, first developed by English watchmaker George Daniels in 1974, improved upon the lever escapement by eliminating friction from the ruby pallets, and has been described as the greatest watchmaking innovation in the last two centuries. Even things taken for granted nowadays, such as jewel bearings and hacking, were ground-breaking in their day.

The most high-profile innovation in the 21st century is the introduction of silicon into watch movements. While watchmakers are eager to improve on movements and complications, they have always been slow to incorporate new materials. After all, brass and steel have sufficed for hundreds of years. This is the reason why, when Ulysse Nardin unveiled their (aptly named) Freak watch in 2001, with a silicon 'Dual Ulysse' escapement, the watchmaking world was shocked to the core. A movement without pallets, jewels, or lubrication?? Initial reactions aside, it had piqued the interest of watchmaking giants Rolex, Patek Philippe and The Swatch Group, who set up a consortium to back research by the Swiss Center for Electronics and Microtechnology (CSEM) into monocrystalline silicon.

Presumably this was money well spent, as in 2005 Patek Phillippe, surprisingly so as one of the most traditional watchmakers, released their collection of watches featuring the new, completely lubricant free silicon Silinvar® escape wheels. According to Jean-Pierre Musy, Patek Philippe's Head of Development, "With our first silicon component, the escape wheel, we were just trying to avoid lubrication. But we knew we had gained a lot by having a very, very light material." Since then they seem to have embraced silicon, with the Spiromax® balance spring in 2006, the Pulsomax® escapement in 2008 and in 2011 the GyromaxSi® balance, made wholly of silicon and 24k gold.

The Swatch Group has embraced silicon technology as a focal point in their antimagnetic goals. Its subsidiaries Blancpain, Omega and Breguet have been using silicon springs in watches since 2006, and in 2018 Swatch Group announced that they aim to outfit all 18 of their brands with either silicon or Nivachron® (a recent antimagnetic alloy) springs and Rolex, known to be slow at releasing radical new designs in favour of incremental changes, has still introduced a silicon escapement called Syloxi® in 2014 in a limited number of its ladies watches.

So with the world's most prestigious haute horlogerie company, the worlds most well-known luxury watch brand and a giant conglomerate owning 20 luxury brands all adopting silicon in their timepieces, one must ask oneself, what does silicon do that steel does not?

As discussed already, silicon requires no lubricant meaning longer intervals between servicing, a welcome relief especially for those who blanch at the £450 service price of an Omega, for example. Another key reason is that it is unaffected by magnetic fields, especially important in this electronic age, as a magnetised spring can completely ruin timekeeping. It has a low coefficient of thermal expansion meaning spring constants are not affected by temperature fluctuations. Additionally, due to its photolithographic manufacturing method parts become capable of being manufactured at thicknesses and complexity impossible for steel.

An often-overlooked advantage of silicon is its lightness, being 70% lighter than steel. This reduces the moment of inertia of the balance wheel, meaning less energy dissipated in changing direction up to 15 times a second and thus increasing efficiency. This can be seen most notably in Patek Philippe's Caliber 240 Q Si perpetual calendar movement, which had a 50% increase in power reserve up to 70 hours simply by replacing balance wheel with a silicon counterpart.

Silicon also fosters development, with Girard-Perregaux releasing the Constant Escapement prototype watch in 2008. Exploiting the flexibility of silicon, the 'psychedelic-looking butterfly' (Logan R. Baker, Watchtime) would have been impossible to make with traditional materials.

It is not mechanically perfect, however, as it is fragile and brittle and unlikely to survive a drop. Then again, who would be careless enough to drop a six-figure watch?

When all is said and done, there really doesn't seem to be any reason not to use silicon. However there is a vocal anti-silicon brigade who believe that photo-etching and space age materials go against the craftsmanship and art form of a true 'handmade' watch.

Indeed George Daniels, the creator of the previously mentioned coaxial escapement, has expressed his disapproval of silicon, saying "I don't believe they're necessary, no. There is no evidence that they are. Clocks and watches have been made of brass and steel for a thousand years, and they're still running perfectly. We don't need these things. I don't accept these materials as being the least bit useful in haute horlogerie".

Sébastien Chaulmontet, Head of Innovation at Sellita, said that although silicon does present some advantages, it has been grossly exaggerated. He says "The widespread adoption of silicon is not something which should be an aim for itself, it only makes sense for certain uses. Two main reasons against the widespread use of silicon are its intrinsic fragility and the fact that it is not repairable by a watchmaker as it needs specialists. Therefore, silicon brings an obsolescence factor into the mechanical watch, which is fundamentally against its core attributes of longevity, reparability in the long run, etc." What he means by this is that if companies are so quick in adopting new, 'revolutionary' materials, what will happen when the next new thing comes out and silicon is forgotten? Will a silicon watch still be repairable? Patek Philippe have a policy whereby if you bring them any Patek watch, however old, they will service and repair it for you, and if the watch contains a broken part which is not produced anymore they will craft a replacement especially.

All well and good for steel, but will they be able to maintain that promise when the watchmaking industry has moved on from silicon?

In addition, as touched upon by Mr Chaulmontet, the incorporation of silicon into a watch makes repairs by local watch repair companies impossible, as specialist equipment is needed to disassemble and clean any watch containing silicon parts. If silicon were to become the norm, this would lead to the downfall of some very well established and long-standing local family businesses as well as monopolise servicing to the manufacturer, a potentially dangerous situation.

So, is silicon set to be the next big thing in watch technology? With valid arguments on both sides, one representing innovation, one representing traditionalism, one looking forwards at the future, one looking backwards at its heritage, it seems like only time will tell.

Via https://dmons.swallowthesky.org/post/424378712

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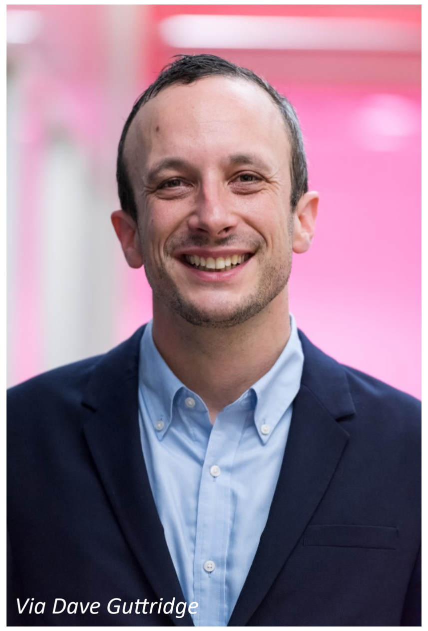
BOMBARDIER BEETLE BUTTS TO PEM ELECTROLYSERS:

A JOURNEY THROUGH HP PRODUCTION AND CATALYSIS

Reehab Jahangir, 2nd year undergraduate, discusses Dr Ifan Stephen's research

Last year, we released 36 billion tonnes of CO_2 into the atmosphere. That is the weight equivalent of 17 million London Eyes. Imagine something ludicrous; 17 million London Eyes rolling across the world, wreaking havoc and destruction at its wake. That is precisely the kind of irreparable, invisible, and insidious damage we are causing the Earth. As future scientists and engineers, and first and foremost as human beings, it becomes our heavy burden to chip away at the core of the questionable practices we use to make our wondrous world and rebuild them in more sustainable ways.

Materials and chemical processing (Smelting for iron, Bayer process for aluminium, Haber Bosch process for ammonia, Anthraquinone process for hydrogen peroxide, to name a few) for use in other industries have left us with massive global greenhouse gases emissions that require immediate attention. Progress is being made in this crucial field, with promising alternatives being proposed by scientists in and out of Imperial College London. Dr. Ifan E.L. Stephens's research deals mainly with powering large scale industrial processes with renewable energy and investigating electrochemical catalysts that will make them more energy efficient. His revolutionary research into the electrochemical production of HP has led to the establishment of Hpnow, a spin out company focusing on the production


Via Dave Guttridge

Dr Ifan Stephen

of in-situ hydrogen peroxide for various applications in agriculture, cleaning, bleaching, and antiseptic agents.

H_2O_2 is extremely toxic to somatic cells, as it produces hydroxyl radicals in a *Fenton* reaction that can break down other molecules, which is exactly what makes it so lucrative. However, H_2O_2 is also a metabolic waste product, and our body has an enzyme called 'catalase' that decomposes it before it can form hydroxyl radicals. However, H_2O_2 is produced as the lesser of two evils, as the superoxide (O^-) ions that are accidentally produced in the well-choreographed circus of metabolism are used to form HP, with the enzyme 'superoxide dismutase' catalysing the reaction. Superoxide sounds villainous because they are biologically so. They cause us to age, so we have HP to thank for our prolonged youth, and maybe someday we can evolve to eliminate superoxide ions from our body completely and achieve immortality. Digressions aside, a lot of inspiration can be drawn from the sophisticated biological catalysts that have evolved over millions of years and tailor so specifically to a certain reaction.

The **anthraquinone process**, curiously enough, is the reduction version of the reaction that the Bombardier beetle uses to protect itself. Alkyl-anthraquinones(R-$C_{14}H_8O_2$) undergo redox reactions, producing HP, acting as a catalyst. The HP produced is dissolved in water and then extracted via fractional distillation. This accounts for almost all industrial HP production, which is a massive problem. The HP produced is extremely concentrated, and is unstable, oxidising explosively. The transportation of such a volatile chemical is extremely costly in term of energy, along with the purification it requires. The anthraquinone catalyst is also prone to degradation, and large amounts of organic solvents are required.

Direct synthesis of H_2O_2 is also possible, combining H_2 and O_2 over a tailored palladium catalyst. However, the problem lies in the tailoring of the catalyst which is factorised by the activity on surface and selectivity of material. This is because of the intermediate reactions that lead to HP production. The H2 molecule binds to the surface, dissociating into H atoms, which are then combined with adsorbed O_2 molecules, forming *OOH radicals, which finally form a H_2O_2 molecule. Therefore, the rate is controlled by the energy associated with these steps, and the catalysts can have to have their selectivity tailored to suit HP production.

Finally, the electrochemical HP production process, which is what Hpnow uses, is driven by solar energy and consists of scalable devices that can be used in homes, crop fields, hospitals etc. The electrochemical process, depending on the electron pathway, can either produce HP (2 electrons) or undesirably, H_2O (4 electrons). Therefore, the electrode used must be well tailored to HP production, and a clever approach to this was detailed in the paper 'Toward the Decentralised electrochemical production of H_2O_2: A Focus on the Catalysis', co-authored by Dr. Stephens, where Proton Exchange Membrane (PEM) electrolysers that are used to split water are used to produce H_2O_2, evolving oxygen and H_2O_2 in pure water. Therefore, there are no contaminants present, and the HP is diluted automatically. The authors were also able to narrow down catalysts and catalytic conditions that would suit HP production through rigorous theoretical analysis and testing.

By better understanding the elegant nature of catalysts, we can develop technologies which skip millennia of evolution, that could potentially save us from being choked by our destructively wonderful creations, shining a beacon of hope into a world currently befuddled by greenhouse gases.

Source: Charles Hedgcock

ELECTRIFYING WOMEN:

PAST AND PRESENT OF WOMEN IN ENGINEERING

Amy Tall, 4th year undergraduate, recounts the panel discussion hosted by WomenInSTEM society in collaboration with MatSoc.

On the 11th of February 2020, MatSoc and WOMENinSTEM@IC jointly hosted an event to celebrate the International Day of Women and Girls in Science. The first half of the evening involved an eye-opening presentation delivered by Dr Elizabeth Bruton and Dr Emily Rees, who discussed their work within the Electrifying Women project and introduced us to some female engineers from the 19th and 20th centuries. This was followed by a dynamic panel discussion, addressing topics such as the role of professional bodies in encouraging and supporting women in STEM, and how the environment for women in STEM has changed over the last 100 years. Finally, the evening concluded with a networking reception, at which hungry staff, students and guests chatted while enjoying nibbles and drinks.

To honour the centenary of the Women's Engineering Society (WES), the Electrifying Women project was initiated in June 2019, with the aim of raising awareness of the contribution of women to the engineering discipline since the 19th century [1]. Dr Bruton and Dr Rees explained that, though female engineers have been written out of conventional history, analysis of a wide range of sources (including census data, patent records and autobiographies) reveals the existence and impact of female engineers, even before the First World War [2]. Dr Bruton and Dr Rees kindly introduced us to a selection of these women, and I have included some information about two of those involved in Materials and Metallurgy below.

Constance Tipper (née Elam, 1894-1995) was a British metallurgist who researched brittle fracture, the ductile-brittle transition and the plastic deformation of metals [3] [4]. She was one of the first women to study the Natural Science Tripos at the University of Cambridge and later became the only female full-time member of the Department of Engineering (between 1949 and 1960) [2] [3] [4]. In the early years of her career, she worked as a research assistant to Sir Harold Carpenter in our very own Royal School of Mines, researching recrystallization and crystal growth in metals [2] [3] [4]. Later, she worked with Sir Geoffrey Ingram Taylor at the Cavendish Laboratory to research crystal plasticity [3], with both researchers being awarded the Royal Society Bakerian Medal in 1923 (though Tipper was unable to present her work as she was a woman) [4]. Perhaps most notably, Tipper explained that Liberty Ships (welded steel cargo ships produced during the Second World War) were failing catastrophically due to the operation of ships in temperatures below the ductile-brittle transition temperature of steel, as opposed to weld defects [2] [3] [4].

"female engineers have been **written out of conventional history**"

Marion McQuillan (née Blight, 1921-1998) was also a British metallurgist, performing some of the earliest research on titanium alloys and metals for use in the context of nuclear energy [2] [5] [3]. After graduating from Girton College (Cambridge) with a degree in natural sciences and metallurgy, she went on to work at the Royal Aircraft Establishment in Farnborough (1942-1947) where she researched materials for use in jet engines, including titanium alloys [5] [3]. Following this, she briefly researched metals for use in the context of nuclear energy at the Atomic Energy Research Establishment [5]. In 1951, she was employed by Imperial Metal Industries (IMI) to develop titanium alloys, where she was promoted to the head of the Titanium Alloy Research Department in just two years [5]. While still working for IMI, McQuillan and her husband co-authored the textbook 'Titanium', published in 1956, a comprehensive text of great importance within the field [5] [3] (the library has a singular copy if anyone needs some light bedtime reading!). In the following years, McQuillan was appointed the technical director of the New Metals Division of IMI (1967) [2] [3] and became managing director of Enots (an IMI subsidiary) in 1978, which was noteworthy as she was the first woman to be appointed a managing director within IMI [5].

Dr Bruton and Dr Rees mentioned many other influential female engineers (and often women's rights activists). These included Hertha Ayrton (thought to be the first female electrical engineer in the UK), Lady Katharine Parsons, Rachel Parsons and Lady Margaret Moir (cofounders of WES with four other women), Caroline Haslett (electrical engineer, first secretary of WES, and founder of their journal, 'The Woman Engineer') and Cleone Benest (founder of a stainless steel company that employed only women) [2].

To conclude, the event was informative and highly enjoyable, and I think it is safe to say that everybody in attendance left with a greater appreciation of the diverse roles of women in engineering throughout history. The outlook on the recruitment of females in STEM fields was generally optimistic, while there was a palpable sense of anticipation for the future achievements of women in engineering and other STEM disciplines.

Thanks are extended to the guest speakers, Dr Elizabeth Bruton and Dr Emily Rees of the Electrifying Women project, and to additional panellists Dr Jess Wade, Dr Patricia Forcén and Katherine Grant. For those wishing to learn more about the project and the female engineers mentioned here, further information can be found on the Electrifying Women website (electrifyingwomen.org) or by emailing electrifyingwomen@gmail.com.

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A MIDSUMMER DAY'S WORK EXPERIENCE:

A GUIDE TO UROPS

Adam Cliff, 2nd year undergraduate, gives advice on UROPs

Sometimes a picture can say a 1000 words and other times a picture can have 29 words and be even more powerful. Those of you with expertise in logic games have probably found out why the picture on the left has a problem. A job is experience. A career-savvy student like many of us here at Imperial will understand the trick to addressing this is internship opportunities. Imperial runs one of the best goings when it comes to academic research, with its UROP program.

"I don't want to go into research" you exclaim, with the confidence that going to a QS top 10 world ranking university will be enough to get you into the big banks, accountancy firms, engineering companies and consultancy, but why not add research experience to your resume, surely it can help!

To break down the abbreviation, UROP stands for: undergraduate research opportunity program. A whole program run by the university to help students interested in doing research at Imperial. Most students must do research as part of their degree, it's all part of being an MEng. Still, when I talk to students, I find that people seldom want to do PhDs and if so, scorn at the idea of doing it here at Imperial.

I believe UROPs are the solution to this. Showing students, the great freedom that comes with academia, can challenge themselves mentally while doing dynamic and interesting work. So I'll try and spread the vibe (and some resources).

The first stop on your adventure is to read about what research goes in the department. You can start by going to the department website and looking for research areas. The areas cover "energy, environmental protection, transport, electronics and healthcare" which means there is something for everyone. Even modelling for you banking wannabes.

You also must think about the academic that will be in charge. There are plenty of them in the department, one of the things about "world leading universities" lot of good researchers. Different academics have pros and cons:, if they are experienced, they may not have much time as they have many other students (PhD, MSc or MEng), you may even not be working directly with them but be looked after by a PhD. Or if they have too much experienced, they may have too much time on their hands. Sometimes the big name may not be the best supervisor, and if you ask any PhD student (which you will be able to on your UROP), a supportive supervisor is the most important thing. Also another trick, companies these days stalk you on social media, why don't you reverse uno that and stalk the academics on twitter and LinkedIn to find out more.

Once you've found your dream academic in the area you are interested in, maybe have a look at what they do. Look at a paper maybe (could only be the abstract if you don't want to stress too much), see if you would be useful or if it has you interested enough to work on it for a long duration. A wise man once said to me, I don't care about crap on your CV just show you can do the job well and will be fun to work with. I think that is a solid statement.

From there get in touch and show your interest and your capabilities maybe even have a physical conversation, it shows you are social. The UROP website is pretty good for this stuff (check out the QR code on the right!)

Then we get to the big dog, funding. Because as we all know, money makes the world go round, especially when renting in London. There isn't much of it, and for some of us it can make or break whether we experience the wonderful life of research or go to the shady world of corporations (wears a suit #sellout). So here are a few little things I've seen:

- There are grants for undergrads from bodies outside imperial. From London livery companies, especially if you like metal, to the EPSRC there are lots of opportunities out there.
- Why not approach a company with a proposal (probably best to ask an academic first)

The last point is write for the MatSoc magazine and about your favourite research topic/lecturer and show them a physical proof of your enthusiasm.

Overall, I've had a great experience with doing UROPs and I hope all of you join me in this great and versatile experience that adds an extra learning curve to your Imperial education.

BIOMIMICRY:

INSPIRED BY NATURE

Enora Saule, 2nd year undergraduate, describes the biomimicry panel talk hosted by the Natural Materials Association.

3.8 billion years of life evolution have led Nature to come up with astounding mechanisms and functionalities to respond to specific, complex and symbiotic situations. For most of the challenges we face, a natural, optimized and low carbon solution already exists, and we need to take inspiration and adapt it to our human needs. This taps into biomimetics, an interdisciplinary scientific field which aims at examining nature's processes, designs and strategies closely, in order to mimic them and use them to rethink our manufacturing, designs and consumer principles. No need to reinvent the wheel when all the blueprints are already available, and open for adaptation!

The Natural Materials Association has launched a trio of online lunchtime seminars revolving around this topic and available to all. Hosted by Christopher Holland of Sheffield University, 3 panellists were present on June 17th to give a brief overview of their respective research fields. These included examining snail mucus for medical and robotic applications, how nature allows for speed and colour by designing highly precise nanostructures as well as an introduction to bio-integrated design using microalgae to purify polluted waters.

Christopher Holland began by recalling the 9 principles of Biomimicry, as stated by Janine Benyus in her book Biomimicry: Innovation Inspired by Nature, follow 9 rules. These are:

1. Nature runs only on sunlight
2. Nature uses only the energy it needs
3. Nature fits form to function
4. Nature recycles everything
5. Nature rewards cooperation
6. Nature banks on diversity
7. Nature demands local expertise
8. Nature curbs excesses from within
9. Nature taps the power of limits

He then described a hot research topic in biomimetics: spider silks, and the ongoing research to mimic its incredible properties from a simple synthesis based on proteins and using the simplest solvent of all. As well as being able to elastically deform under high stress and strain, spider silks are also known for their antimicrobial and antiviral properties. However, artificial silks are yet to be commercially available.

Moving on to another type of surprisingly interesting polymer: mucus. Consisting of 95% water and 5% protein, mucus is a substance created by many living beings, especially snails and slugs, as a defence, locomotion and communication mechanism. Locomotion mucus is a dilute viscoelastic gel, used to overcome sharp obstacles and leave a recognizable trail. This particular type of motion has been adapted to robotic motion, allowing robots to slide over obstacles effortlessly and thus be suited for rougher terrain. In addition, adhesion mucus, used by the snails to stick on variously oriented surfaces, has been used to inspire medical glues, and thus repair bleeding and laceration. This bio-glue is much stronger than our common polymer glues, characterised by a high resistance to debonding and the capacity to withstand stretches of up to 4 times its length.

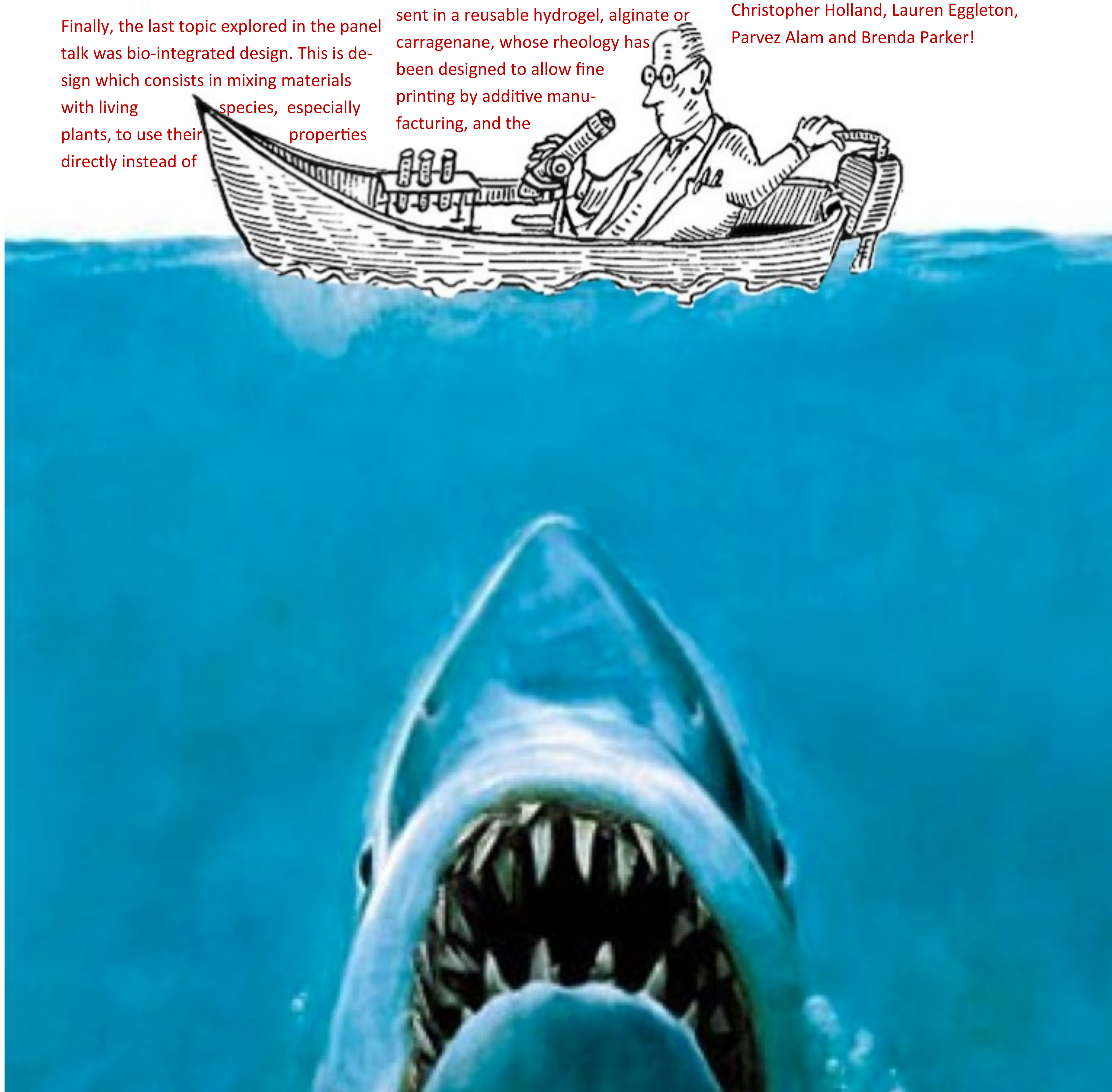
Nature has also come up with intricate designs to allow exceptional speeds and vibrant colours as defensive or reproductive strategies on a wide scale range. To illustrate the first case, let's talk about sharks. Their skin is covered by complex channelled platelets, which enable the creation of water vertices and eddy currents and therefore reduce drag. This enables the shark to reach significant speeds when hunting. The geometrical design of the platelets has been simplified to geometrical primitives and is used in swimsuit design, influencing swimmers so much that these were banned from the 2012 Olympics! Similar nanostructures create colourful effects, for example in tarantula spiders and butterflies. Instead of creating colour by reflecting light on pigments, these animals possess small structures which

act as diffraction gratings and allow for constructive interference of incoming light waves, leading to iridescent effects. Mimicking this system remains technologically difficult as additive manufacturing is not sufficiently precise at this scale, even to replicate structures from the simplest geometrical primitives. An example application of this is in creating bank notes which are difficult to counterfeit.

Finally, the last topic explored in the panel talk was bio-integrated design. This is design which consists in mixing materials with living species, especially plants, to use their properties directly instead of replicating them. This is interesting on a variety of length scales, up to the architectural scale, to make our buildings more adaptable responsive to variations in temperature, humidity etc. The project that was shared here, named the Indus Projects, involves the development of microalgae on ceramic tiles to mop up heavy metals found in highly polluted metals, as the algae absorb them. The algae are present in a reusable hydrogel, alginate or carragenane, whose rheology has been designed to allow fine printing by additive manufacturing, and the ceramic tiles have a high surface area to volume ratio.

They have been hand pressed by the local Indian community who will benefit from it, ensuring acceptation and integration of the project as well as providing local jobs.

Biomimicry is a vast and exciting field, open for creativity and innovation for a more sustainable future. Thank you to Christopher Holland, Lauren Eggleton, Parvez Alam and Brenda Parker!



THE ASSESSMENTS IN THE RYE:

IT’S ALL ABOUT THE EXAMS

Saimei Kuroda, 4th year undergraduate, explores the necessities of tomorrow’s education system

At some point in our education, we all get that talk from one academic or another, that “it’s not just about the exams”. Conceptually speaking this is true; after all, we are here to learn something by our own will. It’s about what we learn, and not just preparing for exams. But is it really? To think about this, I’d like to briefly touch on the idea of e-learning integration into our education.

I personally made the decision to become a software engineer in autonomous driving, working to implement holistic connectivity beyond autonomous vehicles, extending to any IoT device. Simply put, it is the idea of integrating autonomous driving into our lifestyle, rather than leaving it as an isolated technology. We are starting to see this movement in other sectors too, where people are trying to bring technology closer to our daily lives, thereby enabling streamlined cross-functionality of technologies. We expect education to follow suit, with e-learning platforms being well-integrated into our learning experience, however this is far from the case.

As Bert Lance from the Carter administration once said, “If it ain’t broke, don’t fix it”. Our education system is no different, in that there is minimal visible effort being made to move towards a more integrated e-learning experience. Sure, there is some improvements in the curriculum itself, but not so much in terms of modernising the *way* we learn. Many of us couldn’t care less, as it did not directly influence our education; but then COVID-19 happened.

The “it’s not just about the exams” narrative completely broke down with COVID-19. We just couldn’t find a way to judge their students’ capabilities with anything other than a written exam. In the end, it didn’t matter if it was the worst pandemic in decades, exams needed to happen no matter what. We have academics and leaders that believe in exams as the only way to assess their students fairly, so how is it “not about the exams”?

To me, this incompetency of finding a better solution to exams has a lot to do with the ignorant attitude toward modernising the way we learn. There are two main platforms in our education, Blackboard (a Virtual Learning Environment – VLE), and Panopto. Panopto is purely a backup recording platform. Essentially, we don’t even *have* an e-learning platform.

The first step into implementation of e-learning would simply be the transition of lecture content to online platforms. As we know, Imperial Business School created their own Business Hub, where they host many of their lectures. Further, the private sector has taken an active approach in developing such tools, with Google Classroom being proactively used in secondary education. While there are many arguments to not use Google Classroom, such as lack of Learning Management System (LMS) integration and Student Information System (SIS) integration, it is needless to say that it can always be used as a stand-alone technology as well. Such platforms have evolved into extremely interactive environments, whereby the delivery of content can reach a larger group of students at a more intimate level than that of traditional lectures. While it does require a change in mentality by both the staff and students, successful implementation would allow for more time to be allocated to student-staff interactions about the concerns raised by individual students, rather than time being spent on delivery of the content. Additionally, a larger variety of courses can be provided to students, without concerns of clashing lectures. Nevertheless, an intricate balance between in-person lab time would be crucial in order to avoid becoming a fully online course.

As of now, most implementations of e-learning in higher education is in the form of an online degree. However, we need to move towards better utilising and integrating the technologies we have, to formulate a new format of e-learning that is appropriate to the day and age, even without a looming pandemic forcing us to. This modernisation of our education will inevitably change the way people get assessed as well. If every other sector is driving towards deisolating technologies and bringing them closer to our daily lives, so can education. We already have the technology available, now it’s time to use it wisely.

Via Thomas Angus, Imperial College London

REMOTE REALITY 2:

KEEPING UP WITH THE DEPARTMENT

Dr Jonathan Rackham and Dr Priya Pavan share their experience of the move to e-learning

The Curriculum Review process encouraged us to look at the content of the degree programmes on offer, listen to what our students had to say about its delivery and make wholesale changes in repackaging the essential content in a more functional way. The workload is better balanced across the programme years, with core elements extending into Year 3; transferable skills introduced from the start and design study in Year 1 alongside laboratory work focused on developing students' practical and reporting skills.

Given our large involvement in the development of the new portions of the curriculum, the teaching load for Year 1 in the summer term was the primary focus for the Teaching Fellow team. This included four newly designed labs and three lecture courses, one of which had not been given before. In addition to this the Department had a huge logistical problem to solve: ensuring remote assessments would be conducted and marked in a timely and robust way. At the forefront of everyone's minds throughout this process was ensuring that all students would have equal access and be able to participate in an equal way. Fortunately, large pieces of coursework—Year 4 projects, Year 3 design study—had been mostly completed; enough that the transition wouldn't be too detrimental. More worryingly, there was the spectre of MSc projects on the horizon. Would the situation resolve in time for these to continue as normal?

There were many challenges to delivering labs remotely, biggest of which was that we couldn't expect students to have a fully equipped lab in their homes! This required all the labs to be redesigned (again); components needed to be created, visualised and tested; supporting documents written; and GTAs trained. All this within the six-week period before summer term began and while we were transitioning to remote working as well. Year 1 received four such labs, covering the same material but with new delivery modes—working with existing data, using simulations, and carrying out 'kitchen chemistry' experiments.

> **"The time requirements** for preparing this style of flipped delivery **are daunting"**

For the new Electrical Properties lab, we had students using LTspice, a circuit simulator that allows the probing of an electrical circuit, to study dielectric materials. Students used the software to model smooth and rough plate capacitors, look at how the capacitance/impedance is affected by pores of different size and geometry within the electrode. Then, by using a materials selection database, they could explore different dielectric materials and conductive polymers.

For the revised Rheology lab, students were initially going to explore the viscoelastic behaviours of different borax–PVA compositions using a lab-based rheometer and detailed predictive techniques. In the end they carried out a similar experiment, but instead of working in the lab, they used ingredients they could mostly find in supermarkets and measured the behaviour of their slimes with basic equipment available to them. As in a normal lab session, students were asked to work in groups, however this time everyone was on Teams with their webcam on, getting their hands dirty while still experiencing a collaborative environment.

The approach to remote lectures this term was split. Some of the lectures were still delivered in the usual 'classroom style', however the majority were delivered as 'flipped' courses with lectures recorded as (hopefully) short videos that can be watched in advance. Turning around the lecture courses for remote delivery in this way quickly became an exercise in video editing! The time requirements for preparing this style of flipped delivery are daunting but hopefully give a better experience for the audience.

It is a testament to the students and staff in the Department that the term and all of the activities were such a success. This has shown the capability for resilience and adaptability that defines a world class Department, and sets new bounds for the levels of possibility.

Cutting a (very) long story short—we're only a little bit ahead of you guys! We're trying to keep the wheels on and deliver an experience for you that is as close to what was planned originally. The patience and enthusiasm of all of you was essential to that: thank you!

Via Thomas Angus,

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Scanning electron microscopy (SEM) image of hybrid scaffold for bone bonding.