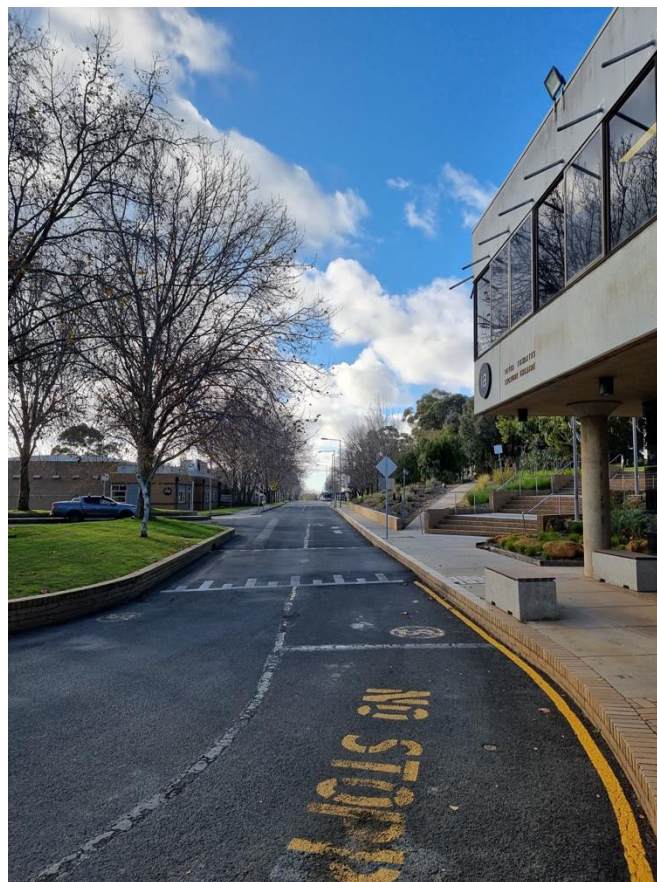


# Visit to the Institute of Frontier Materials of Deakin University

Melbourne, Australia – 4<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the Institute for Frontier Materials (IFM) of Deakin University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA.



During the first day of their visit (Monday 11/7) the Greek researchers were greeted by **Dr Emma Prime** (Manager of Strategic Research at IFM). Dr Prime presented current research pillars of IFM along with its relationship with Deakin University. IFM is focused exclusively on advanced research using MSc and PhD candidates along with established scientists with PhD or Professorship. Research is funded by Australian and International Industry along with Government grants via CSIRO (Commonwealth Scientific and Industrial Research Organisation).

Currently IFM has around *fifty researchers* who are occupied exclusively with their research whereas in case some teaching, and training is necessary, this is taking place in Deakin University.

Challenges created by the recent pandemic were addressed and mutual experiences concerning online, and live courses were discussed.

Professor Priniotakis presented UNIWA, Department of Industrial Design and Production Engineering along with his research laboratory of which he is the current director. He also presented the Erasmus mobility program that is not well known in Australia and the opportunities it presents for students and research staff.



The UniWA team made a tour of the extensive laboratory facilities of IFM with the help of Dr **Dylan Hegh** (Manager of Circular Economy). Laboratories are specialized according to the research area, like analytical chemistry, metal recycling, textile quality control, fibre production, creation of nanostructures, and protective textiles, among others.



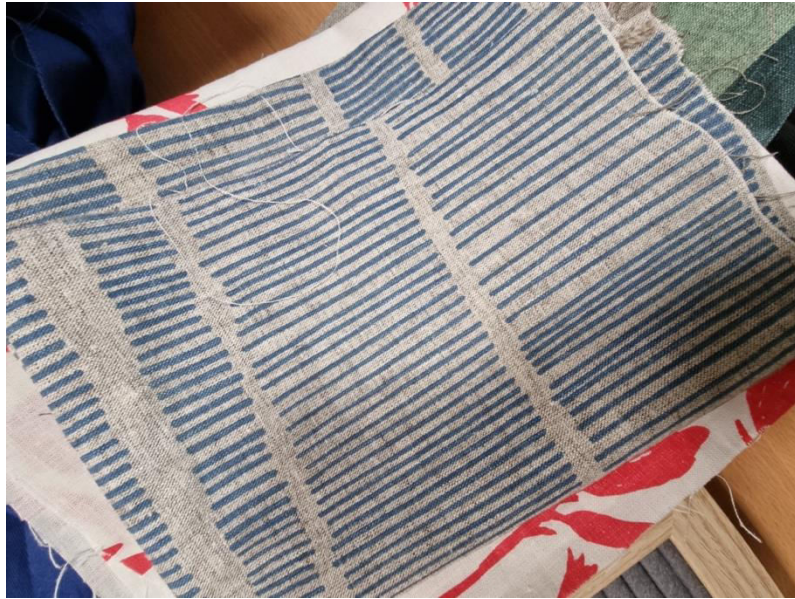


The Institute can scale up its production of research products from laboratory, to mini – industrial scale, in certain areas and technologies. They consider this an advantage, and they try to maintain this ability despite the cost involved.



Dr Hagh analysed his specialty area, i.e., that of **sustainability and circular economy** explaining that currently this is one of the primary areas of research for IFM. He presented current innovations of the Institute’s research in areas of bio-cellulose (produced from recycled food products), pigments from recycled denim fabrics and metals. Bio-cellulose was of particular interest as it is produced by a patented fermentation process and has better mechanical properties than Lyocell. Pigments from recycled denim were used in conventional textile printing with very promising results. Additionally, fibre recycling processes are investigated where the polymer is not downgraded during recycling.





The UniWA team was invited to the multimedia amphitheater of IFM in order to present to the Australian partner the sending institution. Professor Priniotakis made a presentation of UniWA, along with the Department of Design and Industrial Engineering and the DiKniGA research laboratory that he is head of. The presentation was attended by twenty researchers and members of staff while other researchers were attending via livestreaming. Prof. Priniotakis outlined the research projects carried out on DiKniGA underlining the ones that have mutual interest and potential for collaboration. Special mention was made to the WeTeam Advanced MSc course along with the MSc in Circular Economy that will run in UniWA during the next academic year.

From the outcome of the day's visit Professor Priniotakis proposed several areas of collaboration between the two institutions mainly and not exclusively in:

- Education and advanced curricula
- Post-graduate courses
- Research projects in sustainability and recycling
- Visiting lectureship and distance learning
- Masters by Research degrees
- Occupational Health and Safety curricula
- Scaling up of research outcomes from laboratory scale to semi-industrial using the IFM facilities





# Visit to the Institute of Frontier Materials of Deakin University – Meeting with research teams – Day 1

Melbourne, Australia – 4<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the Institute for Frontier Materials (IFM) of Deakin University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA. During their visit, the UniWA team met with research groups of IFM. The format of the meetings consisted of 30-minute presentations of each research team, in a multimedia enabled roundtable. During the presentation, the UniWA team mapped the **areas of research** of each group and underlined potential areas of **collaboration**.



## Research Group 1: Short polymer fibre team

The research group made a presentation of their projects. Their research is focused on making use of short fibre and short polymer products, usually produced via recycling. Their most common way of application is via **small fibre dispersions** with different “carrier” materials. The challenge of small fibres from recycled materials that they cannot control the size of the produced material. Their dispersions have been used in various forms of **textile finishing**.

Another method of small fibre application is via **micro-encapsulation**. Using a novel technological approach, they have incorporated pigments into micro-encapsulates, along with a **magnetic particle**, thus enabling the removal of the remaining encapsulates via magnetism.

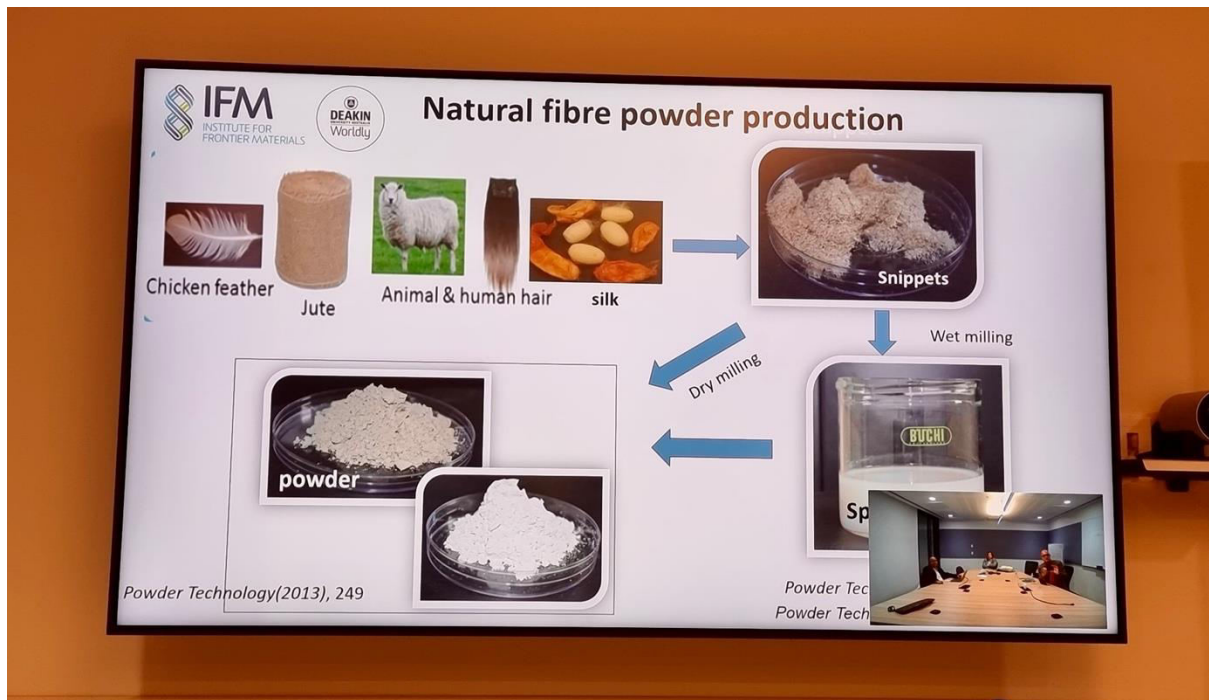


A very promising application of the team's work is that of creation of **pigments** from recycled coloured textiles. They have created some pigments out of this research with a very promising case being that of recycling denim to produce a light blue pigment that is successfully applied via conventional textile printing.

The team also researches the creation of **bacterial cellulose** using novel approaches as **fermentation**.

Professor Priniotakis appreciated the wide range of group's research and invited members of the group to participate in live or online lectures on UniWA's MSc course on sustainability.





## Group 2: Professor Rangam Rajkhowa

Professor Rajkhowa has a background in Textile Technology with specialty in spinning. His research specialty is focused on creating small particles from recycled textiles (similarly to Group 1) but currently he is working in biomaterials produced from **silk**. His research has shown that silk can be a very promising material to create bio-compatible products for humans. He mentioned that his research has led to the creation of a **membrane for an artificial ear drum**, based on silk protein. The UniWA team discussed the issue of **biodegradability** of these products.

Professor Rajkhowa believes that silk is a very sustainable and versatile fibre. He discussed the properties of **eri silk** that is very popular and important in countries like India, China and Japan. Finally, he discussed the importance of **creating value from waste**, and his work in creating regenerated materials like pigments and fibre precursors from the waste of the garment industry.





## Visit to the Institute of Frontier Materials of Deakin University – Meeting with research teams – Day 2

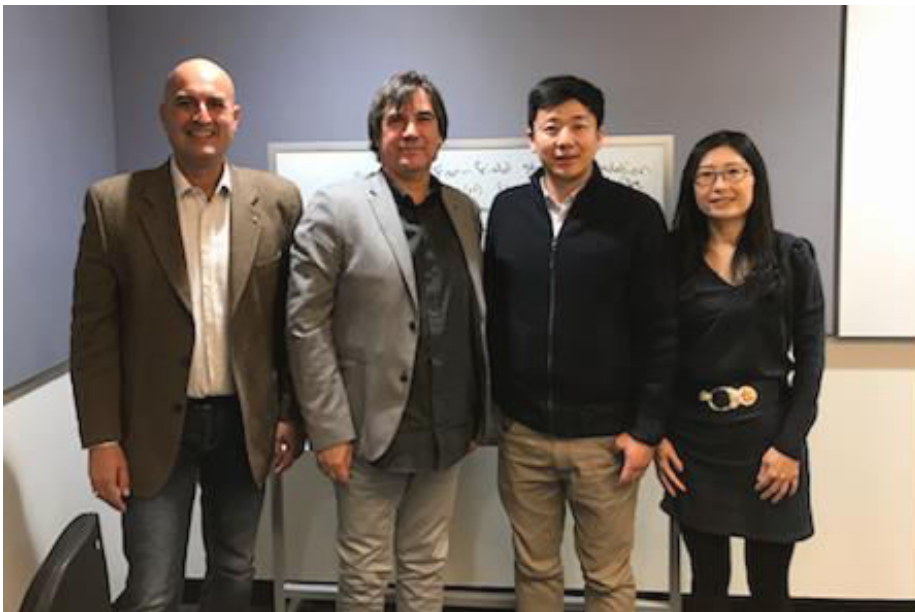
Melbourne, Australia – 5<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the Institute for Frontier Materials (IFM) of Deakin University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA. During their visit, the UniWA team met with research groups of IFM. The format of the meetings consisted of 30-minute presentations of each research team, in a multimedia enabled roundtable. During the presentation, the UniWA team mapped the **areas of research** of each group and underlined potential areas of **collaboration**. See also (IMF for labs, IMF 4-7-2022).

**Kommentar [DAAT1]:** Να μπουν συνδέσεις στα προηγούμενα 2 κείμενα.

### Research Group 3: Prof Weiwei Lei and Dr Dan Lui

The research group made a presentation of their projects. Their research is focused on advanced flexible materials, nanomaterials, and membranes. They have a wide array of applications for the materials they produce. For instance, their nanomaterials can be applied as surface finishes on **performance textiles** to create a **warm** or **cold** effect on the body. They have laboratory equipment that produces **plasma** in various forms that enables them to apply hydrophobic membranes on various materials including textiles. The group's research currently examines the application of new types of **filters** but also the production of **flexible batteries** with higher capacities and more charging cycles. Innovations on batteries in Deakin resulted in the creation of a spin-off company that will soon have a small-scale production unit inside the research centre.





#### Group 4: Dr Chris Hurren

Dr Hurren is focused on applied research in collaboration with the industry. He has a testing laboratory for motorcycle protective clothing. His team has created a program called MOTORCAP that specialises on safety ratings of motorcycle protective clothing and accessories. He explained that where the EU has some standards ever since 2008 concerning the motorcycle protective clothing, Australia has nothing yet, nationwide because such standards are difficult to establish since there are seven states in Australia that in certain areas have independent laws and rules.



*Dr Hurren's laboratory*

Dr Hurren is interested in road safety and road quality aspects. The UniWA team suggested collaboration on the MOTORCAP project probably investigating the transfer of innovation from EU protective standards to Australia.



### Group 5: Dr Maryam Naebe

Dr Naebe made a presentation of her research objectives along with four members of her research group. The majority of her projects are funded from the industry, and she names the umbrella under which she contacts research: "Wonderful wool". Some of the projects are:

- Insulation for the Automotive Industry (Ford Motor Company) from wool waste
- Electroconductive fabric from waste for automotive heated car seats
- Wool powder (they imparted to it good thermal stability) and they apply it to numerous areas as:
  - o Coating of fabrics
  - o 3D printing projects
  - o Artificial leather
  - o Fertiliser
- Wool from Alpaca waste to produce pigments for the coloration of acrylic fibres.

The group also researches potential applications from cellulosic waste like:

- Cotton gin trash to create bioplastic cellulose.
- Lignin from cotton to create UV shielding materials
- Regenerated cellulose with modified properties like coloring to be used in nappies.
- Flexible plastics
- Cellulose nanocrystals
- Water resistant biodegradable paper
- Denim waste (2 million tons of denim waste per annum):
  - o Production of non-wovens via starch binding
  - o Denim bioplastic

Finally, Dr Naebe explained some novel textile dyeing techniques using plasma.



The UniWA team commented that the research team's projects are highly aligned. Prof. Priniotakis mentioned that his research laboratory has already two proposals for research namely:

- Using of wool waste from sheep and goats in Greece especially from some Greek islands
- Using of hair waste from hairdressers to produce filters.



### Group 6: Professor Jingliang Li

Prof. Li explained his research focusing on modified wool-based materials for water purification but also for power generation. His research is in advanced areas and on a wide array of applications. His focus is to produce advanced materials in a more economical way. For example, electrospinning of fibres with an economical production. Wool fibres have been used in various forms for:

- Desalination of water
- Antibiotic degradation
- Generation of electricity (wool fabrics treated with plasma generate current in aqueous baths)
- Antibiotic detection
- Antibody detection
- Membrane filtration



# Visit to the Institute of Frontier Materials of Deakin University – Meeting Carbon Nexus

Melbourne, Australia – 5<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the Institute for Frontier Materials (IFM) of Deakin University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA. During their visit, the UniWA team had the opportunity of visiting the Carbon Nexus facility and discuss with the researchers of the group headed by Dr Filip Stojcevski.



IFM is a centre of innovation for carbon fibre research with extensive laboratory facilities specialised at producing carbon fibres and relative products even with industrial scale machines maintaining the competitive advantage of scaling – up the research from laboratory to larger scale. The UniWA team had the opportunity to discuss and learn about the current challenges in carbon fibre production but also about the technologies that enable the production of durable, lightweight materials for a wide array of applications like bicycles, car bodies, aerospace and other.





*Production of carbon fibres*



*Industrial scale machinery for the production of carbon fibres*

## Visit to the RMIT University – Meeting with Carolina Quintero Rodriguez

Melbourne, Australia – 6<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the Institute for Frontier Materials (IFM) of Deakin University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA. During their visit, the UniWA team had the opportunity of visiting School of Fashion and Textiles at RMIT University. The UniWA team met Dr Carolina Quintero Rodriguez, lecturer at the School of Fashion and Textiles (F&T)



*Professor Priniotakis with Dr Rodriguez at the Library of the School of Fashion and Textiles (F&T)*



Dr Rodrigues arranged a visit of the UniWA team in all the facilities and laboratories of the RMIT F&T while explaining the curriculum, research aims and structure. There was a discussion on the setbacks on academic education from the lockdowns relating to the COVID situation. Initially there was a visit to the fashion laboratories that were recently renovated. Subsequently, the team visited the library and the computer cluster laboratory where there is a network of powerful computers aimed at the CAD applications relating to textile and clothing design, among others.



*Visiting the Computer laboratories*

Professor Priniotakis exchanged research ideas with Dr Rodrigues concerning smart textiles and clothing with focus on triboelectric textiles and renewable energy. They also exchanged ideas on how to manage different levels of academic teaching and training since RMIT F&T has significant experience on *vocational training* on emerging technologies and needs of the labour market.

Dr Rodrigues explained the structure of the School which was very interesting as it focuses on current and up-to-date needs of the textile industry. The School consists of three course directions (departments) as follows:

1. Fashion and Design – this is focused on clothing design, productions and aspects of fashion
2. Fashion Management – this is focused on managerial aspects of textile production including logistics, economics, international trading, marketing and quality control, among others.

3. Sustainable Innovation - this incorporates more advanced and research areas of textile production like finishing technologies, recycling, new materials and aspects of sustainability, among others.

The UniWA team noted that the aforementioned structure is very interesting and modern. It could be used as a guideline for the re-emergence of a **new department for Textiles and Clothing** in UniWA.

Finally, there was a long discussion on projects that are currently undertaken by Professor Priniotakis' research team and potential collaboration areas were underlined.

## Visit to A2I2 Institute of Deakin University

Melbourne, Australia – 7<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the Institute for Frontier Materials (IFM) of Deakin University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA. During their visit, the UniWA team had the opportunity of visiting the Applied Artificial Intelligence Institute (A2I2) and meet with the Co-director Mr Con Mouzakis and Research Fellow Dr Irene Logothetis. Both researchers are of Greek origin and were happy to meet co-patriots from UniWA and establish a common ground for mutually beneficial projects.



*A2I2 and the UniWA team at the entrance of the laboratories*

Mr Mouzakis explained that A2I2 is committed to pushing the boundaries of AI. The institute is a top Australian research body focusing on Human-centred AI. A<sup>2</sup>I<sup>2</sup> tackles real-world problems using methods grounded in modern machine learning and deep learning to make discoveries to advance knowledge and build systems that can benefit society. He showed the research laboratories of the institute and explained the non-confidential projects, since there also many projects that relate to defence and other similar areas. Of particular



interest was the “Talk with Ted” AI program for dementia. This is a realistic online simulation designed to support respectful communication with people living with dementia. It is a safe and effective way to practise communication skills. Participants who have experienced Talk with Ted were able to recall their learnings up to eight weeks following the training and say it has improved the overall quality of care they give. This was winner of the 2020 Victorian iAward in the Not-For-Profit and Community Solution of the Year category.



*Demonstration of the Talk with Ted AI training program*

Professor Priniotakis commented that in UniWA a similar project has run that was dealing with AI and dementia and that it is in the process of finalising the details concerning the bio-ethics committee before going public. Both teams agreed that they will cooperate on this field after September 2022 when Mr Mouzakis is planning visiting Greece.

Another project of interest was AI for biology and health. The A2I2 team showed a project where AI assists first aid respondents quickly assess the steps that should be taken in a hospital’s **emergency room**. A demonstration of the program was shown and tested. This was also one of the award-winning programs of the institute. The institute has a specialisation in **healthcare applications** with a wide array of research ranging from autism prediction to keeping of medical records and making predictions from them.

Finally, the UniWA team visited laboratories where simulations of airplane navigations were running and other laboratories where human movement is monitored along with real-life response to events fed via augmented reality.



*Augmented reality and human response laboratory.*

Both UniWA and A2I2 teams found the visit very productive and realised that there is common ground on their research interests that can surely lead to future collaboration combining the comparative advantages of each institution.



# Visit to RMIT – Department of Fashion and Textiles

## Meeting with Professor Rajiv Padhye and collaborators

Melbourne, Australia – 7<sup>th</sup> July 2022

On the first week of July 2022, Professor Dr George Priniotakis from the Department of Industrial Design and Production Engineering of the University of West Attica, along with Research Associate Dr Athanasios Tsoutseos, visited the RMIT University in Melbourne Australia. The researcher's mobility was realised via the Erasmus program of UniWA. During their visit, the UniWA team had the opportunity of visiting the School of Fashion and Textiles and meet Professor Rajiv Padhye along with his collaborators Professor Lijing Wang and Dr Xin Wang.

The UniWA team discussed many subjects with the RMIT team, mainly on the following areas:

### Organisation of the AUTEX 2023 conference

Professor Priniotakis informed the RMIT team that Professor Savvas Vassiliadis for UniWA is the new president for Association of Universities for Textiles (AUTEX) which is a prestigious position in recognition of his personal and UniWA's contribution to the field of textile research. The next **AUTEX International Conference** is planned to take place in Melbourne Australia under the hospices of RMIT. Professor Padhye suggested to take advantage of the different set of seasons of the northern hemisphere and plan the conference for November 2023 instead of May which is the most common month for conferences. This will make the participation more attractive as May is usually "fully booked" for academics and the industry with many consecutive conference plans. Details concerning the time difference, hybrid participation (online and live) along with aspects of the opening ceremony were discussed. Professor Priniotakis discussed the parallel sessions, recording for offline attendance and scientific fields of each session. There was an extensive discussion on the publication of the conference papers with reference to SAI & SCOPUS indices. Additionally, he underlined that to enable industrial participation the Melbourne and Australian Industry should be involved with keynote speakers. The title of the conference could not be finalised during the meeting as there were many ideas as **smart textiles, sustainability, and forensics**.

### Master Course in Forensic Textiles

Professor Priniotakis informed about a new course in Forensic Textiles that is planned to start in Greece under the hospices of UniWA. RMIT has a similar course and experience of running Master courses in a mixed environment and curricula. For instance, they explained that they have a similar course in Entrepreneurship that is obtained by mixed attendance, that is, maximum 30% can be online, some lessons are finalised by coursework and there is also conventional attendance. This mixture is flexible for people from the industry or abroad who want to attend and complete the course.

Specifically for Forensics RMIT has a 1-year course on this subject. This is created by RMIT team, in co-operation with the Australian, the New Zealand and the US Governments. RMIT

will provide the curriculum details along with any support needed to UniWA, in order to design a similar course, focused on Greek and European needs in Greece. Dr Xin Wang provided the team with links and details of the corresponding RMIT program.

## Final visit to IFM – Meeting with Professor Joselito Razal and his research group

*Melbourne, Australia – 8<sup>th</sup> July 2022*

The final meeting of the Erasmus mobility to Melbourne's IMF Institute of Deakin University was with Head of Research Professor Joselito Razal and his extended research group. Professor Razal explained to the UniWA team his research focus after the resignation of Professor Xungai Wong, who was the previous Head of Research during the past 25 years. The general umbrella title of the research group in IFM is "Fibres and Textiles Research Group", the overall capacity being 56 people doing research with a corresponding number of PhD students. There are more specific sub-groups headed by **research leaders** with specialities according to group focus and the leader's comparative research advantages. Professor Razal's sub-group is under the "Smart textiles" research area.



Professor Priniotakis presented the UniWA team and explained the structure of laboratories as entities in UniWA, analysing the research efforts and focus of his lab. Additionally, he discussed the potential for **collaboration between IMF – Deakin and UniWA** in the Horizons 2020 framework. He also informed about the **AUTEX 2023** conference that is planned to take place in Melbourne next year. Present in the meeting was Dr **Irene Logothetis** from **A2I2 Institute**, so that she could also contribute to the brainstorming session of potential collaboration with UniWA.

Subsequently, Professor Razal suggested his team to present their areas of research. The highlights of the presentations are as follows:



- Dr **Sima** has a background in Chemical Engineering. She has done research in **carbon fibre products**, reinforced **composites**, and **aerospace** composites, among others. Her PhD project has been in **Graphene** and **thermoplastics**.

- Dr **Nighaz Azadeh** is working in **fibre-based biosensors** and **wearable biosensors**.

The products of this research have been applied to:

- Infection treatment
- Kidney failure treatment
- Sport injuries
- Parkinson's disease.

Additionally, fibre base biosensors are cheap sensors for quick testing relating to food safety like:

- Salmonella detection
- Detection of chemical contamination
- Presence of antibiotics etc

The research has also given rise to novelties in **food packaging** with **antibacterial properties** with the incorporation of **ZnO** nanoparticles.

- Dr **Ken Aldren Usman** has a background in Chemistry, Material Chemistry and Processing along with Characterization and an MSc concerning the extraction of high value nanomaterials from **agricultural** and **volcanic waste**.

His PhD research is focused on **MXenes** that are a class of two-dimensional inorganic compounds. These materials consist of a-few-atoms-thick layers of transition metal carbides, nitrides, or carbonitrides. First described in 2011, MXenes combine the metallic conductivity of transition metal carbides with a hydrophilic nature because of their hydroxyl- or oxygen-terminated surfaces. MXenes have **high conductivity** and **high capacitance** but are **brittle** with **poor adhesion properties**. Dr Usman uses some **sequential bridging methods combining MXenes with cellulose fibres** or **silk**, to make these materials more applicable.

- Ms **Christine Jurene o Bacal** has a background in Chemistry and her MSc research has been on **cellulase enzymes**. Her PhD research is on **selective drug capture** specializing in **paracetamol overdose**. She has created specific filters and membranes that filter certain medicines. She also has done research of hollow fibres that may be used in such filtration systems.

- Mr **Ahmed Rashid** is working on **novel membranes for photo-electro-catalytic reactions**. He has a background in chemistry. He has produced **water desalination membranes** as a joined project between **Lintec and Deakin**. His research expands to wider wastewater treatment applications with focus on the **removal of pharmaceutical products** from wastewater. He explained the challenges of the approach using **catalytic layer and a carbon nanofiber membrane**. Additionally, he

explained the **catalytic and photocatalytic properties** of carbon nanotubes. His aim is to create of **photocatalytic membrane reactor**.

- Mr **Jizhen Zhang** is working on **Electrical Function** fibres. He has wide research on these materials using nanomaterials, CNT, Kevlar nanofibers, graphene, graphene oxide, and MXenes among others. He explained methods like **polychromatic diffraction** and **micro-CT**. The application of his research is in **supercapacitors for electric vehicles, EMI shielding** and sensors.