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TechConnect World Innovation Conference and Expo 2019

Commercialising research in advanced materials and sustainable manufacturing

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Introduction

The TechConnect World Innovation Conference and Expo event has been held annually for the past 20 years and has alternated location between Boston, USA and California, USA. The 2019 conference was held in Boston between the 17th and 19th of June 2019 and attracted over 3000 participants from across all pillars of the ecosystem. The conference will be held in Washington DC, USA for the first time next year.

The aim of the conference is to connect top applied research and early-stage innovations from universities, laboratories and startups with industry end users and large corporates across the following themes, each with their own parallel stream:

- Advanced materials
- Advanced manufacturing
- Energy and sustainability
- Electronics and microsystems
- Biotechnology, medical, pharmaceutical and consumer
- Artificial intelligence (AI), machine learning, informatics and modelling
- Personal and home care, cosmetics, food and agriculture

There were also two poster sessions over the three days and a large exhibition space with over 250 exhibitors showcasing and demonstrating their novel technologies and inventions.

Commercialisation of R&D

The keynote panel discussion 'Inspiration to Innovation Commercialization of R&D' took place on day one of the conference. The panel consisted of Alex Fensore (Sherwin-Williams, USA), Emily Riley (Energizer Holdings Inc, USA) and Chris van Buiten (Lockheed Martin, USA). There was discussion about needing both incremental and transformational innovation at different stages and in different places across an organisation and bespoke approaches and processes in place to run and manage each type effectively.

All panel members emphasised the importance of starting incremental innovation from capturing internal and customer unmet needs, followed by looking to see what capability is already in place or can be easily sourced to solve the problems and then collaborating externally to fill any gaps where necessary. There was less of a consensus on how to succeed at transformational or disruptive innovation.

The panel's top tips for innovators were:

- Understand what your customer needs
- Know what you want to be great at – then work out how to get there
- Be bold and be brave.

Innovation Spotlight: Composite Materials, Films and Coatings

One of the highlights of each of the sessions was the Innovation Spotlight slot. During this time each of the sponsoring companies has an opportunity to pitch to the innovators in the room and describe the company, its vision, ethos and goals and especially the types of challenges they are facing and where they are looking for new advanced materials. The innovators in the audience found these slots particularly useful to guide the areas to target their future research. If an innovative solution can be matched with a known problem that a large company is facing, then the route to commercialisation for the technology can be made easier.

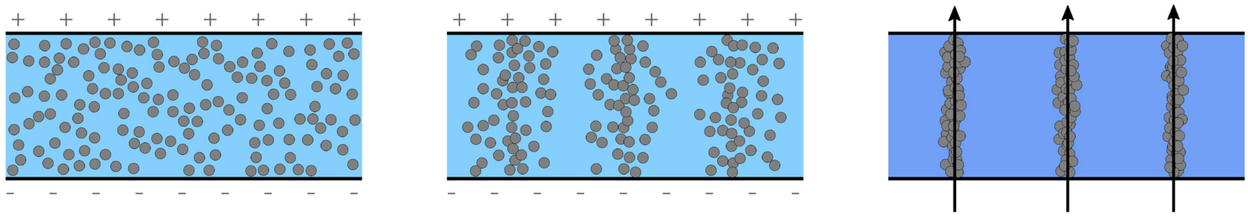

Fig. 1. Alignment of particles when exposed to an electric field in conductive films with anisotropic properties made by CondAlign, Norway (Image used with permission)

Then followed a number of seven minute selected pitches from university technology transfer offices or startups looking for seed funding, licensing partners or commercialisation partners. Among the pitches in the Advanced Materials Innovation Spotlight (sponsored by AGC, USA and Magna, USA) were a selection summarised here.

'CompPair Technologies', A. Cohades (Laboratory for Processing of Advanced Composites, EPFL, Switzerland) (1). Composite materials are formed by combining materials together to form an overall structure with properties that differ from those of the individual components. They are used for a wide range of applications from wind turbine blades or aircraft wings to boat hulls and masts, surfboards and buildings. High performance and lightweight composites that are composed of fibre and resin can be susceptible to damage by fatigue or exposure to dust or projectiles, even small impacts can cause microcracks, which leads to bigger cracks and potentially catastrophic part failure. CompPair has developed a 'prepreg': a fibre-based repair agent that is incorporated directly throughout the composite materials on production and remains dormant in the part until activated to enact self-repair of the composite. The healing process requires only moderate temperatures of 70–85°C, easily achieved with a hand-held heat source and takes only one minute. The incorporation of the repair agent uses existing manufacturing routes and assets, maintains the mechanical performance of the original material and can extend the equipment's lifespan by up to three times. The company is looking to trial its repair additives in new composite materials.

'Enabling New Technology for Anisotropic Conductive Films', P. M. Lindberget, CondAlign, Norway. CondAlign has a patented technology for producing a range of conductive films with anisotropic properties known as anisotropic conductive films (ACFs). Anisotropic materials can be described as having directionally different material properties. For instance, the material can be insulating in one direction and electrically conductive in another. The films are usually comprised of conductive particles and a polymer matrix. The mechanical properties of the films are mainly given by the matrix, while the conductive properties are defined by the particles. An electric field is used to structure and align the filler particles in a liquid matrix (**Figure 1**). When applying the electric field, electric dipoles are induced in the particles causing chain formation. The alignment occurs due to electrophoresis, therefore it is also possible to align non-electrically conductive or magnetic particles. CondAlign has demonstrated production of films with a wide range of different parameters. It is demonstrated in roll to roll production, making the process scalable and cost effective. The process is material independent and is applicable to a wide range of applications.

'Surface Coating for Reduction of Aerodynamic Noise and Vibrations', C. Smith (Texas Tech University, USA). Flow separation is a phenomenon considered to be responsible for increased vibration and drag along with higher energy consumption in vehicles. The team at Texas Tech University have focused on solving this problem using passive control *via* bio-inspired surfaces. Using a material analogous to the denticles on a shark's skin, they have developed a passive microscale fibrillar coating that significantly reduced flow separation. This micro-texture energises the fluid adjacent to the body by creating local suction and blowing, delaying separation and giving a smaller wake leading to reduced noise and vibrations. A feature of shark denticles is the asymmetric geometry (**Figure 2**) (2). The denticles are created initially through a process of etching and casting, however once a mould is made it can be used almost indefinitely allowing for cost-effective scale up. Initially focusing on wind turbine blades, they managed to achieve 30% drag and noise reduction and are looking for partners to co-develop solutions for specific applications where noise and vibration reduction are important.

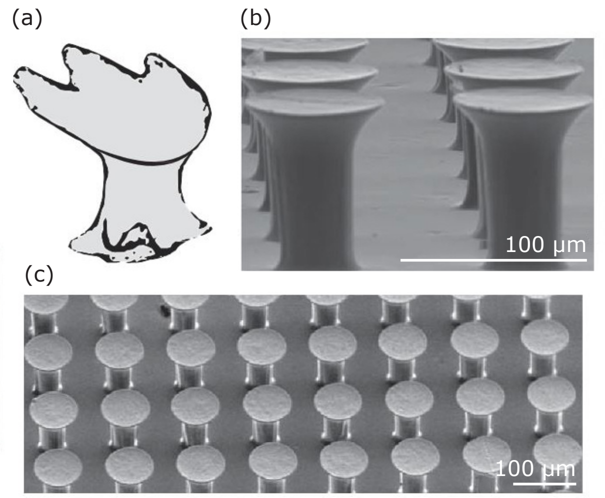

Fig. 2. (a) Shark denticle shows a divergent shape with an asymmetry in the wall-normal and streamwise directions; (b) and (c) microscopy images of the micropillar arrays, which have a similar asymmetric shape (2) Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND)

'Polyethylene Terephthalate (PET) Aerogels', G. Wee (National University of Singapore (NUS)) (3). With much in the news currently about plastic waste, the team at NUS has created a cost-effective approach to fabricating recycled polyethylene terephthalate (rPET) aerogels from waste PET fibres obtained from plastic bottles. The high surface area rPET aerogels were fabricated through hydrogen and ester bonds formed between polyvinyl alcohol (PVA) and the rPET fibres and acetal bridges from a glutaraldehyde (GA) cross-linker. The rPET fibres were fully immersed in sodium hydroxide (NaOH) solution to produce carboxyl and hydroxyl groups on their surface. This was heated in an oven for 1 h at 80°C to accelerate the hydrolysis process. They were washed thoroughly with deionised (DI) water to remove all the remaining NaOH before immersing them into the mixture of PVA, GA and DI water. The pH of the reaction media was controlled at pH 3 by hydrochloric acid (37%) to accelerate the cross-linking reaction. The resulting mixture was sonicated for 30 min at 220–230 W for homogenisation and removal of bubbles. The cross-linking reaction was carried out in the oven for 3 h at 80°C and then placed into a freezer for 6–8 h until the sample was frozen. The frozen sample was placed into the freeze dryer for 48 h to remove all the solvent and produce the rPET aerogel. Full details can be found in their publication (4). The GA cross-linker can improve the interactions between the rPET fibres and the PVA cross-linker. It also reinforces the rPET-PVA fibre matrix by improving its stability and mechanical properties during the curing process (**Figure 3**). The aerogels are very versatile and can be given different surface treatments to customise them for different applications. For example when the surface contains terminal methyl groups, the aerogels can absorb large amounts of hydrocarbons very quickly making them highly suitable for oil spill cleaning. When the surface is coated with an amine group the material can absorb carbon dioxide from the environment. The surface chemistry can be adapted to be able to incorporate the aerogels into lightweight, breathable personal masks that filter out pollutants such as nitrogen oxides and carbon monoxide in places where air quality is of concern. Aerogels also have incredibly poor heat transfer properties, which makes them ideal for using as insulation. When coated with fire retardant chemicals, the material can withstand temperatures of up to 450°C but weighs only about 10% of the weight of traditional thermal lining, this would allow safety equipment such as coats for firefighters to be made much lighter, safer and cheaper and at the same time helping in the global fight against plastic waste.

Awards: Thin Films, Sensors and Coatings

Each year the TechConnect Review Panel identifies and ranks the top 15% of submitted technologies based on the potential positive impact the submitted technology will have on a specific industry sector. Some of the 2019 award winners are listed below.

Click Materials Corp, Canada, is expert in thin film technologies for coating highly efficient catalysts for reduced power consumption and smart glass. It is commercialising electrochromic window technology that is expected to be >50% lower cost than incumbent technologies. Smart windows provide variable tinting capabilities that significantly reduce energy requirements, improve employee productivity and enable the connected smart home.

Chemeleon, USA, is developing a platform technology for a novel chemical sensor with high sensitivity and specificity. The initial application includes a smart colorimetric sensor that can be embedded in drinkware to help consumers become aware of food and drink safety to protect them from date rape drug facilitated crime. It enables instantaneous on the spot detection of many other

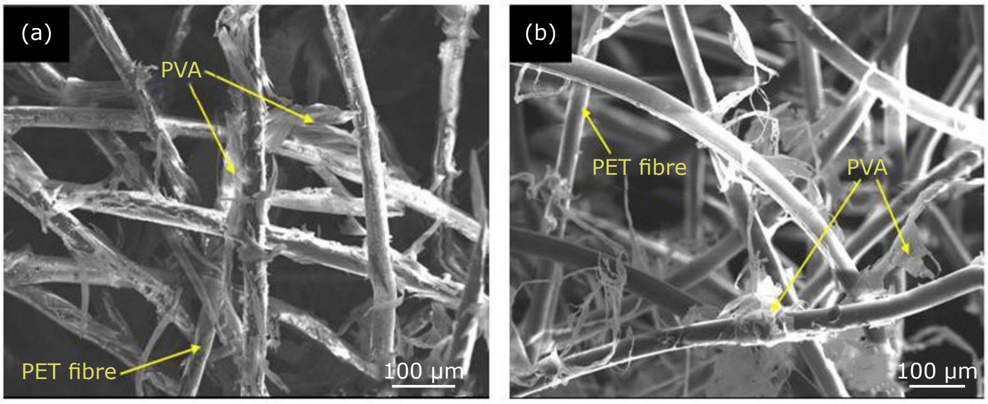

Fig. 3. SEM images show PVA linking the PET aerogel structure (4). Creative Commons Attribution 4.0 (CC BY)

analytes such as volatile organic compound (VOC), explosives or nerve agents and it can also be extended to detect specific biomarkers to enable clinical diagnosis.

Inhibit Coatings Ltd, New Zealand, uses novel silver nanofunctionalisation to produce highly antimicrobial coatings. Silver is a well-known antimicrobial agent effective against over 650 different microorganisms. The novel nanotechnology allows very low biocide concentrations (<0.1%) and exhibits an extremely low leaching <0.1 ppb cm^{-2} over a period of one week fully immersed. This low leach rate and biocide concentration gives rise to robust coatings with a very long antimicrobial lifetime that withstands wash cycles without compromising the physical properties of the resin system.

Conclusions

The overarching themes across all the streams of the conference were about making things better, smaller and cheaper but importantly also more safely, efficiently, ethically and sustainably: using greener solvents and processes, finding alternatives to conflicted starting materials and having a minimal impact on the world's natural resources by considering recycling and cradle-to-cradle lifecycles at the start of the projects. This looks like a trend that is thankfully set to continue with many of the companies and institutions presenting referencing the United Nations Sustainable Development Goals in their drivers and business models.

References

1. S. Aubort, 'A Self-Healing Composite', Ecole polytechnique fédérale de Lausanne (EPFL), Switzerland, 6th March, 2019
2. H. Bocanegra Evans, A. M. Hamed, S. Gorumlu, A. Doosttalab, B. Aksak, L. P. Chamorro and L. Castillo, *Proc. Natl. Acad. Sci.*, 2018, **115**, (6), 1210
3. S. Salomo, T. X. Nguyen, D. K. Le, X. Zhang, N. Phan-Thien and H. M. Duong, *Colloids Surf. A: Physicochem. Eng. Aspects*, 2018, **556**, 37
4. H. W. Koh, D. K. Le, G. N. Ng, X. Zhang, N. Phan-Thien, U. Kureemun and H. M. Duong, *Gels*, 2018, **4**, (2), 43

The Reviewer

Debra Jones joined Johnson Matthey in the Technology Centre, Sonning Common, UK in 2004 with a degree in Chemistry from the University of Birmingham, UK. She has worked across a range of sectors including Fischer Tropsch catalysis, automotive catalysis, solar thermal hydrogen production and natural gas purification. Debra currently works in the corporate innovation team and looks after Johnson Matthey's Open Innovation activities, looking for new technologies and opportunities for Johnson Matthey to collaborate externally, particularly with startups and small to medium enterprises.

