Issue 45 • June 2017

Connection

The official magazine of Composites Australia

Inside

Ground breaking composite machines

Australia's Superfoiler launches onto the world stage

allnex is the market leader in the manufacturing and distribution of composite materials in Australia, New Zealand and the Pacific Islands. We are the largest and only local producer of composite resins such as gelcoats, flowcoats, and unsaturated polyester and vinyl ester resins.

Our materials are used in a diverse range of composite applications and products such as boats, swimming pools, truck bodies, tanks, roof sheeting, pipelines and many more.

We pride ourselves on offering the region's most comprehensive product portfolio and end-to-end service ranging from research and product development to application advice and ongoing technical support.

Our local R&D operations are complimented by our global innovation network. By listening to our customers, identifying trends in the market place, and understanding the specifics of our customers' challenges, we make sure that we undertake development activities that deliver commercially viable solutions.

Globally, allnex is a leading producer of coating resins and additives for architectural, industrial, protective, automotive and special purpose coatings and inks with an annual revenue of €2.2 billion.

With 33 manufacturing facilities, 23 research and technology support centres and 6 joint ventures, the allnex group is present on four continents and serves customers in over 100 countries.

www.allnex.com

Australia: 1800 789 607
New Zealand: 0800 803 001

Contents

Issue 45 • June 2017

Front Cover
Built by Innovation Composites on the NSW south coast, the first of the world's fastest course racing yachts, Superfoilers, are coming off the production line.
Story Page 8.

Feature article

Victorian-based manufacturer MaxiTRANS Industries has secured a $60m contract to supply 395 truck trailers to Coles Supermarkets. With 200 refrigerated trailers in the order, read how the company's innovative composite sandwich panels production line is delivering on the contract.
5

Publisher:
Kerryn Caulfield
Chief Executive

Editorial inquiries:
Liz Tunnecliffe

Advertising inquiries:
Anna Civiti

Design:
Stefan Morris
Tel. 0411 708 279

Connection Magazine
is the official magazine of Composites Australia Inc.
ABN 28 611 244 813
Next issue: October 2017

Composites Australia
17 Rooney Street, Richmond, Victoria 3121
Tel. +61 (0)3 9429 9884
Fax. +61 (0)3 9421 5516
www.compositesaustralia.com.au

President's letter

Welcome to another great edition of *Connection*, with an interesting line up of product features, research innovations and news from the Australian composites industry.

Thank you to all those who joined us at the 2017 Advanced Composites Innovation Conference and Trade Exhibition in late March. The conference provided an opportunity for the industry to connect, develop partnerships, skills and knowledge and promote the development of new markets for composite products.

The inclement weather was a challenge, with cyclone Debbie hitting the Queensland coast just days before, and the follow-on heavy rain having a big impact on the Gold Coast and surrounds. Amazingly, the conference dinner canal cruise out to South Stradbroke Island found a break in the rain and was another highlight of the event.

We had participants from across Australia joined by delegates from China, Korea, Iran, Pakistan, Poland, The Netherlands and Switzerland. The conference gave us an opportunity to share knowledge on a global scale, with over 50 presentations, including the keynote speaker from the USA, Dr John D. Russell, Technical Director, Manufacturing and Industrial Technologies Division of the US Air Force Research Laboratory. A fuller report on the conference is on Pages 10 and 11.

The federal Treasurer's recognition of the importance of small businesses and manufacturing to the Australian economy in his Budget, with promises of tax cuts and removal of red tape are welcome news. The Budget also confirmed funding of $100 million for an Advanced Manufacturing Fund over the next five years. Composites Australia is working with the government to ensure that some of this fund will target the composites sector, which we know is viewed by government as an area of high value manufacturing.

Your association recently delivered a technology workshop on Sandwich Structure Design and Fabrication in Melbourne. Developed and delivered by Dr Rik Heslehurst, the workshop covered the specific design and fabrication requirements of sandwich structure development and provided an understanding of the skin and core selection process. We know that composite sandwich panels are worthwhile materials to form strong lightweight structures, particularly for the transport, aerospace and marine industries in their never-ending mission to reduce weight and increase strength. For example, composite sandwich panels are a significant component of the recently announced MaxiTRANS $60 million contract with Coles (see Page 5).

Our cover story on the Superfoiler Grand Prix profiles the capability of a regional composite manufacturer to meet the demanding challenges of a ground breaking racing yacht design. It's another excellent example of what entrepreneurs and innovators can achieve when they connect and work with an Australian composite manufacturer to realise their vision.

I hope you enjoy this edition of *Connection*, through which Composites Australia continues to profile the sector's capabilities to support growth in the Australian industry.

Keep an eye on the events calendar (page 19) for upcoming activities in your region. I look forward to seeing you at the open day at Australia's most awarded luxury motor-yacht builder, Riviera, who are generously opening their doors to members on the 20th July.

Leona Reif
President

MaxiTRANS $60 m Coles contract boosts composite panel production

Victorian-based manufacturer MaxiTRANS Industries has secured a contract to supply 395 truck trailers to Coles Supermarkets in New South Wales and Western Australia.

MaxiTRANS Managing Director and Chief Executive Officer, Dean Jenkins said the contract was one of the nation's largest for the sector.

"This is a tremendous show of support by Coles in Australian regional manufacturing. Coles' decision to buy Australian-made is not only a vote of confidence that our existing 950 employees build a world-class product, but it will also help to generate more than 100 new jobs over the life of the contract.

"At a critical time for local automotive manufacturing, the order will offer employment prospects to many Victorians.

MaxiTRANS' main manufacturing facility is Wendouree, Ballarat. The composite sandwich panels for more than 200 refrigerated trailers for Coles are being manufactured at the MaxiTRANS facility Hallam Panels, east of Melbourne.

Hallam Panels Manufacturing Manager Peter Kleins says delivering on the contract requires the manufacturing plant to gradually ramp up daily output by 30 to 50 per cent. The existing highly efficient production processes and production line will be able to support this with the recruitment of additional employees working across the current two shifts.

"The thermal characteristics of our sandwich panels are extremely efficient offering significant benefits for refrigerated transport. We have developed and produce our own foam core on a continuous line utilising a tissue carrier. It has an extremely high closed cell count and can be produced to the required thickness without cutting.

"We produce our own fibre glass skins in basically an open mould process and the gelcoat finish is extremely high gloss and durable. The skins and foam cores are moved to the bonding tables for assembly under vacuum pressure.

Coles refrigerated trucks feature highly efficient composite technology under a new contract with Victorian manufacturer MaxiTRANS.

"A typical standard panel on the line would be 14.7 m long and up to 3 m high. These are CNC cut to size for the side walls and roof."

The wall panels are fitted out with rub strips and other components before the complete kit (walls and roof) is put on an A frame for transport to Ballarat for assembly of the refrigerated MaxiCube trailers.

MaxiTRANS says the Coles agreement, valued at approximately AU$60 million, will complement its existing manufacturing volume.

"MaxiTRANS' annual trailer production capacity is unrivalled in Australia. This gives us a unique ability to fulfil an order of this size around our existing output.

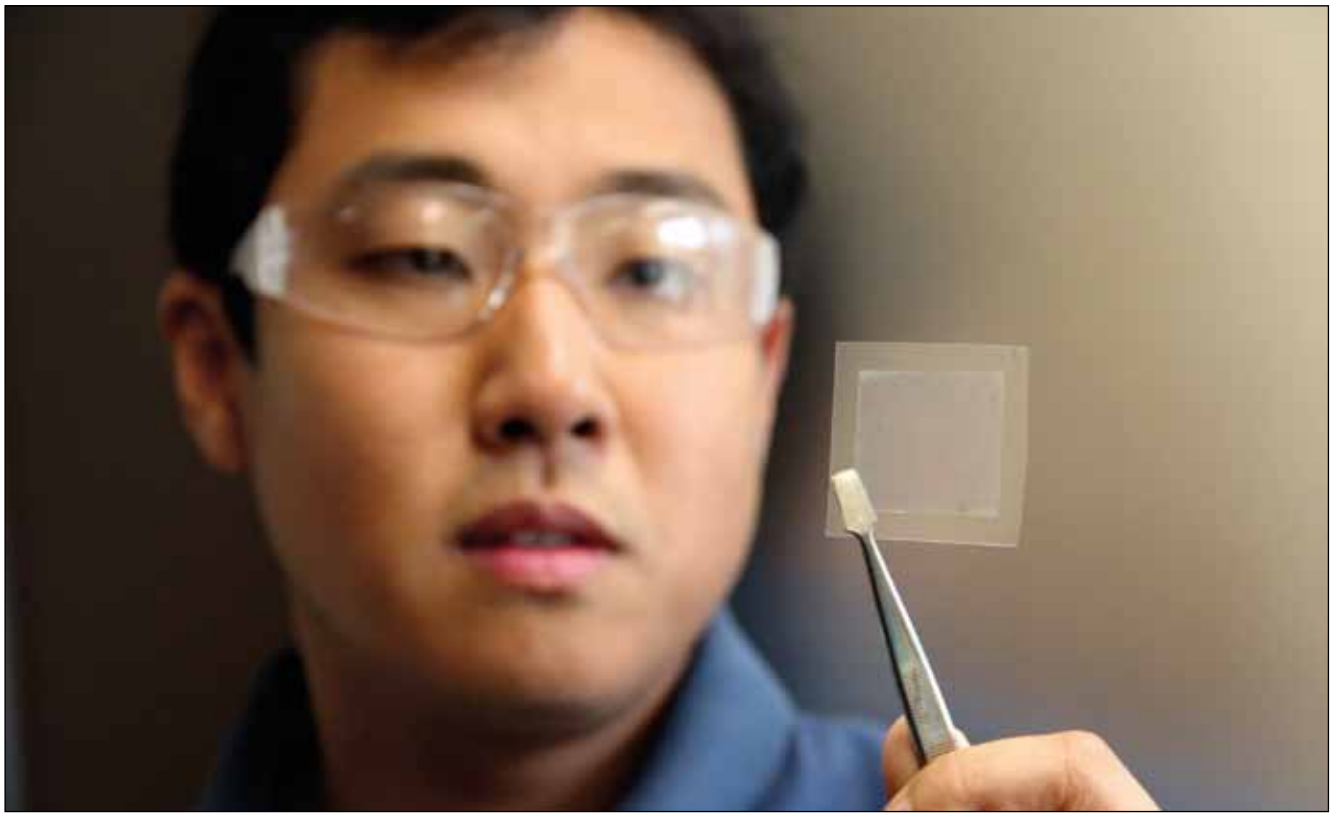
"We pride ourselves on being able to support all kinds of businesses from large fleets to single operators and are excited by this opportunity to show the industry the full extent of our capabilities," Mr Jenkins said.

Coles Head of Transport Tony O'Toole says, "Coles is pleased to be able to support the creation of jobs in regional Victoria through this partnership with MaxiTRANS.

"We are always looking for ways to strengthen our relationships with local suppliers to help sustain the communities we serve every day, and we're proud that deliveries to our stores will be made using trailers produced right here in Victoria."

CSIRO lowers graphene production costs using soy and waste oils

CSIRO scientists have developed a novel technology for the fabrication of graphene from soybean oil which they say will make production of world's strongest material more commercially viable.



CSIRO Scientist Dr Dong Han Seo holds a piece of graphene film

Up until this development, graphene has been grown in a highly-controlled environment with explosive compressed gases, requiring long hours of operation at high temperatures and extensive vacuum processing.

The CSIRO's "GraphAir" technology eliminates the need for such a highly-controlled environment growing graphene film in ambient air with a natural precursor, making its production faster and simpler.

"This ambient-air process for graphene fabrication is fast, simple, safe, potentially scalable, and integration-friendly," says Dr Zhao Jun Han, a CSIRO scientist and co-author of the study published in Nature Communications in January 2017.

"Our unique technology is expected to reduce the cost of graphene production and improve the uptake in new applications."

GraphAir transforms soybean oil – a renewable, natural material - into graphene films in a single step.

"Our GraphAir technology results in good and transformable graphene properties, comparable to graphene made by conventional methods," says Dr Dong Han Seo, a CSIRO scientist and co-author of the study, which was supported by researchers from The University of Sydney, University of Technology Sydney and The Queensland University of Technology.

With heat, soybean oil breaks down into a range of carbon building units that are essential for the synthesis of graphene.

The team also transformed other types of renewable and even waste oil, such as those leftover from barbecues or cooking, into graphene films.

"We can now recycle waste oils that would have otherwise been discarded and transform them into something useful," Dr Seo said.

World-leading commercial production of graphene for conductive smart materials began in Australia in 2016.

Graphene has excellent electronic, mechanical, thermal and optical properties as well as strength. Potential applications of graphene include water filtration and purification, renewable energy, sensors for smart materials, personalised healthcare and medicine. Its uses range from improving battery performance in energy devices, to cheaper solar panels.

CSIRO is looking to partner with industry to find new uses for graphene.

More information: www.csiro.au

Innovative use of composite materials in concrete pipe repairs

By Dan Naiker, Composites Application Support Manager at allnex

Since 1910, more than 300,000km of steel-reinforced concrete pipes have been laid in Australia and New Zealand in drainage, road culvert, sewer and pressure pipe applications. Cured-in-place pipe (CIPP) technology offers a cost effective and non-destructive repair solution for the relining of old and damaged water, sewer, gas or chemical pipelines.

Concrete pipes of today have a long history of excellent performance as a durable product for storm water drainage and sewer applications. While continuous research and development has enabled increased reliability, at some point concrete pipes, especially old ones, will fail and need repair. Digging up old pipelines can be destructive, expensive and time consuming.

A more cost effective solution is offered by CIPP, a cured-in-place pipe system using FRP composites to repair leaking or structurally unsound pipelines. It is a jointless, seamless, pipe-within-a-pipe that can effectively reduce infiltration and leaks without digging. The first CIPP technology was applied in London in 1971 and later commercialised by Insituform Technologies in 1977. The technology entered the public domain in 1994.

As a trenchless technology, CIPP does not require excavation. The liner is often installed through a manhole or other existing access point. A resin-saturated felt tube, made of polyester, fibreglass cloth or other materials suitable for resin impregnation, is inverted or pulled into a damaged pipe through an upstream access point. The liner can be inverted using water or air pressure. The resin, usually polyester, is then cured by hot water, UV light or steam to form a tight-fitting, jointless and corrosion-resistant replacement pipe. In sewer lines, lateral connections can also be restored without excavation via a remote controlled device that drills a hole in the liner at the point of the lateral connection.

A resin-saturated liner is pulled into a damaged pipe through an upstream access point.

Although CIPP offers a great solution, it also has some limitations. Except for very common sizes, liners are not usually stocked and must be made specifically for each project. Curing may take from one hour to 30 hours depending on pipe diameter and curing system, and must be carefully monitored, inspected and tested. Obstructions in the existing pipeline such as protruding laterals must be removed prior to installation. While CIPP can repair a pipe with bends, special design considerations must be taken into account to prevent wrinkling and stretching. The more flexible the liner, the more care needs to be taken during inversion to ensure the liner remains on the correct alignment. Testing of CIPP installations is required to confirm that the materials used comply with the site and engineering requirements.

In its Botany, NSW laboratory, allnex has developed a resin specifically designed for CIPP applications. Polyplex 916 has been formulated to facilitate high cross link density in the cured composite liner. This improves overall chemical and hydrolysis resistance and can result in faster cure rates and shorter curing cycles, dependent on sufficient heat input during the CIPP fabrication process.

"In comparison to other conventional unsaturated polyester resins typically used in CIPP applications, this resin offers various technical and performance advantages, including excellent tensile and flexural properties, high heat distortion temperature and high tensile elongation. This combination of properties typically results in increased toughness and durability in the cured composite liner."

Dean Voice, Technical Service & Business Development Manager at allnex

To demonstrate suitability for CIPP applications, Flexural Creep modulus properties of CIPP composite liners made using Polyplex 916 were independently evaluated and qualified to meet CIPP industry requirements according to ASTM D2990-09.

Infrastructure owners and managers now have the option of composite cured-in-place pipe repair technology (CIPP) which does not require costly and disruptive excavation.

More information: Contact allnex T: 1800 789 607

Superfoiler Grand Prix contenders are groundbreaking composite machines

Father and son Australian entertainment entrepreneurs Bill and Jack Macartney are launching an adrenalin pumping new sport onto the world stage later this year based on a groundbreaking "composite machine".

The first Superfoiler on Sydney Harbour: It's designed to reach speeds up to 45 knots.

Their Superfoiler Grand Prix is based on a radical sail racer design that pushes every element of the carbon composite build and the sailing skills of the three person crew to reach world record speeds across a 2 km course.

"It's a new world sailing machine, fundamentally a sleek high-tech composite machine that races across the water at record speeds on a knife edge," says Bill.

Having thrilled the yachting public for 11 years with the televised thrills and spills of the 18ft Skiff Grand Prix across Australia in the 1990's, the Macartneys had toyed with the idea of a new Grand Prix for some 10 years.

Inspired by the sight of the 2015 hydrofoiling America's Cup contenders rising above the water to race on their foils, and the excitement this generated in the on-shore crowds and television coverage, the Macartneys decided to develop the world's fastest course sailing racers for a Grand Prix Sailing circuit in Australia.

Commissioning world reknown racing yacht designers Morelli and Melvin in Newport California to design the fastest, most exciting course racing sail racers, they have taken the cutting edge design of the 2015 America's Cup hydrofoil catamarans and turned it on its head.

"There are a number of innovations in the boat but the biggest innovation is that it is designed from the foils (the wheelbase) up with the shape of the single hull, two beams, two floats and the sails all designed to lift the boat onto the foils and add knots," says Jack.

The Superfoiler is also designed to be broken down into five major components for transport in four containers to each of the race circuit locations from Fremantle in Perth to Adelaide, Melbourne, Sydney and Brisbane over the summer.

"Having a design that is at the very cutting edge, our priority was to get the best organisation to build the boats," says Bill. "We had submissions from New Zealand, the Middle East and Australia and on analysis of their track record and direct experience we settled on Innovation Composites."

Based in South Nowra on the New South Wales coast 180km south of Sydney, Mark Rowed and his team at Innovation Composites have built several elite racing yachts, including maxi-yacht contenders in Sydney Hobart Yacht Race, but nothing like the Superfoiler.

"It's an innovative design. We worked closely with Grand Prix Sailing through the selection process and contributed suggestions where there were areas we could add our expertise. We wanted to see something like this being built in this country and we obviously like to be involved in a project like this," says Mark.

Working with the designers in America, Innovation Composites developed the high temperature carbon fibre tools for the carbon infused 27ft long hull, two 16ft floats and main beams.

"Weight is everything," says Mark. "They are made of carbon prepeg, Nomex honeycomb, Gurit Corecell, cooked in our boat oven at 85oC. The main beams join everything together. They have over 40 layers, all hand laid up with carbon prepeg, vacuum consolidated every three layers under pressure in the high temperature tool and then through the freezer.

"Keeping the weight to the minimum requires a lot of intricacy, a lot of labour," says Mark. "The first prototype took seven to eight months from concept to product finish. We spent 4500 hours, a lot of that basically working stuff out."

With up to eight people assigned to the project, one of the biggest challenges has been recruiting the necessary skilled people. Job advertisements for one of the most exciting boat projects have drawn little response.

The 2.7m dagger boards and two 2.5m rudders and the masts are being made by Hall Spars and Rigging in New Zealand, drawing on their experience producing dagger boards and masts for high performance racing yachts including the New Zealand's 2015 America's Cup contender.

"They are over-engineered to take the predicted forces. Made of 30 layers of monolithic carbon fibre hand laid up and cooked in the autoclave they are on weight and spec," says Keith, who is personally overseen all aspects of the boat build as well as testing on the water.

Father and son team L/R Jack Macartney, Chief Operating Officer, Bill Macartney, Managing Director.

"Tooling up and creating the mould and putting the first Superfoiler together has been a challenging process that has honed us all," says Bill.

As this magazine goes to press, Jack and his crew are mastering the sailing, and novel new-age electronic control systems on the first Superfoiler launched in March, while Mark Rowed and his team move into production of the five remaining boats for the fleet to be in the water by the end of October.

Grand Prix Sailing has secured a national television rights agreement with Channel 7 and envisage thousands of people gathering on the foreshore to watch each race in the series as it travels from state to state.

The series is scheduled to kick off in December.

More information: www.superfoiler.com

Bright outlook for Australia's composite manufacturers

There is plenty of room for growth for the Australian composites industry, especially in bespoke and high value solutions and products.

This positive outlook was a consistent theme across the two days of the 2017 Advanced Composites Innovation Conference held in Sanctuary Cove, Queensland in late March.

Keynote speaker **Dr John Russell**, Technical Director of the United States Air Force Research Laboratory's Manufacturing and Industrial Technologies Division, set the scene with his outline of solutions needed for the next generation US military aircraft.

His wish list resonated across the audience, and included not only the ability to survive a 50 caliber bullet but the special needs for major step change in a bespoke (niche) product market, such as:

- The pressure to keep the price down when production numbers are small
- New composite materials to support a "leap frog" in performance and cost benefits compared to aluminium
- Design and process step changes for more flexible and efficient production methods, e.g. reduce tooling costs, improve the use of factory floor space, reduce human involvement (affordable automation and robotics for low volume)
- A reliable repeatable bonding process to replace the thousands of bolt holes in the aircraft. "Each hole costs $50 and is a source for error, stress compression …"

Dr Jens Goennemann, Managing Director of the Advanced Manufacturing Growth Centre, said the future for Australian manufacturing lay in products with a unique point of difference; value added products for niche markets rather than mass production. "Australian ingenuity is an asset to offer the world," he said.

Mr Greg Williams, Senior Consultant with CSIRO Futures, continued the theme in his opening plenary session on Day Two, providing a summary of the findings of CSIRO's first roadmap for Advanced Manufacturing growth. Increasing demand for customised and sustainable solutions and services is driving supply chain disruptions and presenting Australian manufacturers with opportunities for bespoke and high-value solutions for global value chains decades.

To realise this potential industry and research needed to jointly tackle issues around technology adoption, skills, collaboration and culture.

The two day proceedings concluded with a session "Future Opportunities" chaired by well-known Composites Australia technical advisor, Dr Rik Heselhurst. Representatives from industry and academia packed the room to listen and contribute to the interactive, energising session.

Michael Kemp, General Manager of Wagners CFT, said the non-corrosive properties of composites made them ideal for infrastructure in marine and other corrosive environments but customers required certification from major engineering companies due to the lack of Australian standards and knowledge of composites.

Composites Australia President Leona Reif with keynote speakers Prof Peter Schubel (University of Southern Queensland's Centre for Future Materials), Dr John D. Russell (Technical Director, United States Air Force Research Laboratory's Manufacturing and Industrial Technologies Division) and Dr Jens Goennemann (Managing Director of the Advanced Manufacturing Growth Centre).

Dr Rik Heselhurst's preconference technology workshop was well received.

L-R: David Busby-Wright (Weir Minerals) with Flt LT Chris Kourloufas (Defence Aviation Safety Authority, RAAF) and Dr John Russell (US Air Force Research Laboratory).

"We need to show what is achievable and put composites in the spotlight in these markets."

Dr Michael Heitzmann, Group Leader Composite Materials and Processes at The University of Queensland, suggested academics should get out into industry to better understand their perspectives, obstacles to innovation and how they can help meet those needs.

He said ambitious, innovative projects required required risk taking and universities had a role to play as "risk sharing partners" for industry.

Dr Lucy Cranich, a materials scientist and Director of PATH, a technical consultancy for polymers: composites, fibreglass, plastics, rubber, coatings and linings sees potential for growth for the Australian composites industry in drones, continuous fibre glass pipe, aluminium replacement, household robotics, water and waste but said the sector needed to be versatile, anticipate market trends and target high value premium products and customers in the market for high value and quality.

Michael Leggett, Director of Oceania Composites Engineering, said key enablers were smart design and smart services and called on the sector to increase collaboration to leverage strengths for mutual growth.

The full two day program featured 50 speakers from industry and leading composite research organisations from Australia, Europe, Asia and the USA. Topics for industry included new developments in fibres, cores, resins and adhesives; a composites marketing tool kit for potential customers, new developments in processing, business transformation, the safe workplace and employee relations.

The 2017 ACSS Best Paper prize was awarded to **Dr Chuang Feng**, research fellow and Australian Research Council DECRA Fellow at RMIT University for his paper Vibration of functionally graded trapezoidal nanocomposite plates reinforced with graphene nanoplatelets, co-authored with research colleagues from the RMIT School of Engineering, Zhan Zhao and Jie Yang.

See page 15 for a conference report by Professor Bronwyn Fox, Director of Swinburne University's Manufacturing Futures Research Institute.

Below. Michael Kemp (Wagners CFT) (centre), chats to delegates from the Lublin University of Technology, Poland: Prof Hubert Debski and Dr Sylwester Samborski

L-R: Hugh O'Donnell (High Performance Consortium) with Frank Cristiano (Tricomposite) and Greg Williams (CSIRO)

Rik Heselhurst with Sadaf Abbasi (RMIT University) and Mazhar Hussain Peerzada (Mehran University of Engineering).

Left. Glen Stuart (allnex) could not resist playing the innovative composite guitar displayed by the University of Queensland - a student project.

Acknowledgements

SAMPE, the Australian Composite Structures Society, in particular Dr Rik Heselhurst who chaired the academic committee, provided invaluable support to the conference organisation.

The exhibitors withstood extremely humid weather conditions brought on by Cyclone Debbie to provide engaging focal points for networking, knowledge sharing and business development discussions. For their time, effort and support we thank: Agilent Technologies Australia Pty Ltd, Airblast Australia, allnex, Carbon Nexus at Deakin University, IMCD, Olympus Australia, Omnitankers, Pacific Resins, Sew Simple Australia, University of Queensland.

A very big "THANK YOU" to our conference sponsors for their support of the Australian composites industry:

Composite Engineer's Viewpoint
By Rik Heslehurst PhD, MEng, BEng (Aero) FIEAust, FRAeS, CPEng

Part 11 A–The Operational Environment

In this article we examine operational environmental effects, such as moisture ingress and temperature, on composite-skinned sandwich structures. The long-term effects of moisture is the specific focus, with other environmental conditions to be discussed in the October magazine issue.

Moisture Ingress

All composite and sandwich structures operate in atmospheric conditions that expose them to moisture, temperature and other environmental conditions, such as:

a. Fluids, including water (salt), fuels, oils, hydraulic fluids, paint strippers, NDI couplant, dye penetrants, etc.
b. Thermal cycling
c. Atmospheric moisture
d. Mechanical, such as acoustic vibration and shock.

When sandwich structures (facings and core) are adequately protected the effects of moisture ingress on mechanical properties are minimal. However, the mechanical properties of composite sandwich structure will degrade with time in adverse environments. The actual degradation occurs mainly to the polymeric resins used in composite skins, skin-to-core adhesive bondline and polymer-based cores. The effect is usually considered in the design studies as ultimate allowable stresses and strains knockdown factors.

Composite Skins. Polymeric matrix, adhesive and core materials like epoxy resins, absorb moisture from the atmosphere by a process called diffusion. Thus, in wet (humid) conditions composite and sandwich structures will gain weight through moisture absorption. In dry atmospheric conditions the reverse process, desorption, will dry out the structure. Graphite epoxy laminated composites can absorb up to 1.5% weight of moisture when exposed to very humid conditions for a very long time (years). Adhesive bonds absorb moisture at a much lesser rate and lower percentage weight gain than composites. Polymeric foams and honeycomb cores can absorb water at the molecular level, like the resins, but also free water can be found in core materials. For the diffusion process to occur the surface must be exposed to the atmosphere, hence surface protection is important.

The diffusion process closely follows the Fick's Law:

$$\frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial z^2}$$

where, $c(z,t)$ is the moisture concentration at depth z over time t, and D is the Diffusion Constant.

The total moisture content (m) in a laminate is obtained by the integration of c(z,t);

$$m = \int_{z=0}^{h} c(z,t)dz$$

For small thicknesses the integral simplifies to the following solution;

$$\frac{m}{m_o} = \frac{4}{h}\sqrt{\frac{DT}{\pi}}$$

where, m_o is the maximum moisture content of the solid laminate
h is the depth of the solid laminate
T is the temperature during the absorption process

There are two main features of moisture diffusion in composite skins. These are illustrated in Figures 1 and 2, and show that:

a. diffusion rate increases with temperature, and
b. longer times are required for thicker laminates to reach saturation.

In reality, the humidity and temperature cycle to which a structure is exposed will result in about 0.8% to 1.0% weight gain for composites in the worst case scenario.

Moisture absorption affects the matrix-dominated properties of composites in that it lowers the glass transition temperature (Tg) — the temperature where

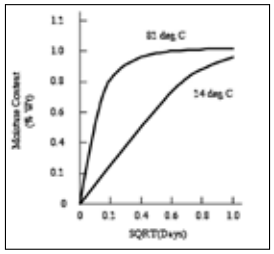


Figure 1: Temperature Effects on the Rate of Moisture Absorption

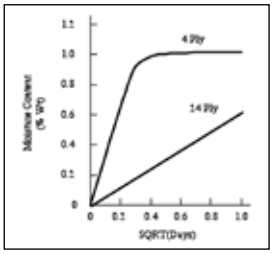


Figure 2: Laminate Thickness Effects on the Rate of Moisture Absorption

the resin material softens above Tg and is more rigid below Tg. A 1.2% moisture concentration drops Tg by 40˚C to 50˚C.

Adhesive bondline. For high strength to be achieved in the adhesive bondline between facings and core, high surface energies on the adherend are required. The high surface energies provide the van der Waals forces (secondary bonding) which hold the joint together. In some cases covalent and ionic bonding can also be achieved when the facings and core are made of appropriate materials. Water or moisture vapour ingress can destroy the adherend surface energy.

Core Materials. The three fundamental core types - honeycomb, foam and balsa are affected by moisture absorption differently:

a. For honeycomb core the first issue is that solid water will pool in the cells. This can add significant weight to the structure and adversely affect performance and dynamic stability. With metallic cores the second long-term issue is corrosion. With non-metallic honeycomb core, the resin used can be degraded causing the core to become soft and spongy. This is well known in aramid paper core materials. This highlights the importance of sealing the core edges during honeycomb core sandwich panel fabrication.
b. There are two basic types of foam core of interest when considering moisture. These are closed and open cell foams. The issue with open cell foams is that moisture can easily propagate and accumulate throughout the foam and has the same issue with added weight of honeycomb cores. Closed cell foams on the other hand will resist the propagation and saturation of the adjacent cells with moisture uptake. The rate of moisture adsorption resistance is determined by the polymer properties of the foam.
c. Balsa has a well known issue with moisture absorption and, like honeycomb cores, need to be adequately sealed so the balsa core is not directly exposed to the wet environment.

In the next article we will continue the discussion on operational environmental effects with the focus on thermal effects and corrosion.

All articles published in Engineer's Viewpoint are available on the Composites Australia website (www.compositesaustralia.com.au/industry). Rik welcomes questions, comments and your point of view by email to rikheslehurst@gmail.com

Growth opportunities in the glass fibre market

Drawing on available market research and 40 years in the composites industry in both manufacturing and global material supply, Composites Australia board member **Steve Brennan**, Director of BI Glass Fibre Pty Ltd sees a bright future for glass fibre composites.

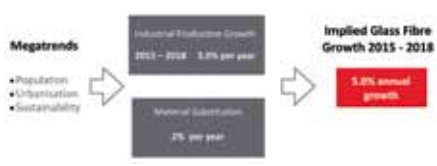
Recently, the Australian government has been focusing on innovation as a driver for the Australian economy, and thankfully innovation has been a major driver for the composites industry both globally and locally since glass fibre was first patented in 1938.

While much of the discussions on innovation refer to carbon fibre reinforced composites, it is important to understand that glass fibre reinforced composites still account for 85% of the volume of the global composites market, and new applications continue to be developed.

Depending on whose numbers you use, global growth figures show glass fibre reinforced composites have grown at 5 to 8% Compound Annual Growth Rate (CAGR) for the past 30 years and forecast this level of growth will continue for the next 5 to 10 years. This is a very healthy growth rate that many other industries would be more than happy to achieve.

"Megatrends" of population growth, Urbanisation, and Sustainability have driven much of this growth, but we also see material substitution as a major driver of glass fibre reinforced composite growth.

Material substitution has been driven by the ability of composites to provide



solutions to a broad range of end markets that see the benefits of composites and is assisted by technical developments in glass fibre reinforcements which have contributed greatly to growing applications for composites. For a long time, E-glass reinforcements were the industry standard, but E-Glass is old technology and would not be able to meet the demands of new applications and emerging markets.

Owens Corning has been at the forefront of developing glass fibre reinforcements to drive the new applications development and has released more than 60 new products since 2013.

These new products have been driven by end-market demands for improved properties, such as higher strengths, lighter weight, better fatigue resistance, or improved corrosion resistance.

Australian composites growth opportunities

The majority of the volume manufacturers in the Australian composites industry are tied to the lower growth segments of Consumer and Marine, although some manufacturers are moving towards improving their presence in some of the higher growth market segments.

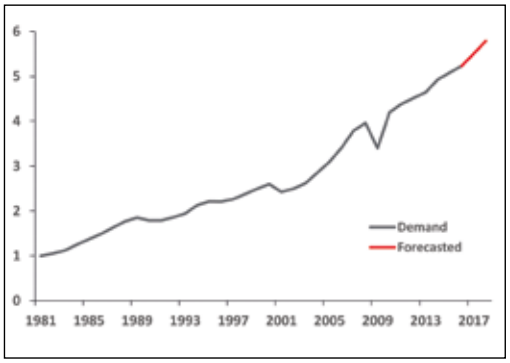
There are also some other very positive drivers for growth in Australia:

- We have a very stable economy and last year saw Australia achieve 25 years of continuous economic growth – the only developed nation in the world to achieve this.
- Population growth and urbanisation leads to increased spending on new and ageing infrastructure.
- State and federal governments continue to announce strong infrastructure spending.
- Consumer spending data remains strong.
- Government legislation is supportive of the advantages of composites – CO2 emissions, renewable energy targets etc.

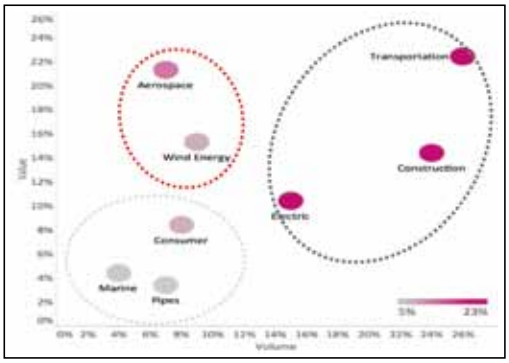
These, combined with available new glass fibre technologies offer opportunities for the Australian composites industry to increase competitiveness and develop new products and markets.

Market analysts identify the following growth projections by market segments:

- High growth in volume and value – Transport, Construction, Electric.
- High volume growth and moderate value growth – Aerospace, Wind Energy.
- Lower growth in volume and value – Consumer, Marine, Pipes.



Glass Fibre Reinforcements Demand - Global



Global growth projections for market segments

A roadmap to grow the Australian composites industry

by Bronwyn Fox, Professor and Director of the Manufacturing Futures Research Institute at Swinburne University of Technology

Swinburne's Prof Bronwyn Fox.

Despite the torrential rain that had many of us stranded in Queensland airports, this year's Composites Australia conference was one of the highlights of the year for me.

We've welcomed a number of new people into our community including early career scientists and engineers and I'm delighted that Professor Peter Schubel has rejoined us to take on his new role at the University of Southern Queensland as the Director of the Centre for Future Materials. He was a core member of the team responsible for collaboratively developing and delivering a national strategy for the growth of the composites industry in the United Kingdom. The role of this team was to maximise the impact of innovative research for the UK, support existing industries, and more importantly, enable new applications and markets in growth areas.

Manufacturing in the UK recently reported the fastest growth for three years on the back of strong demand both in Great Britain and internationally.

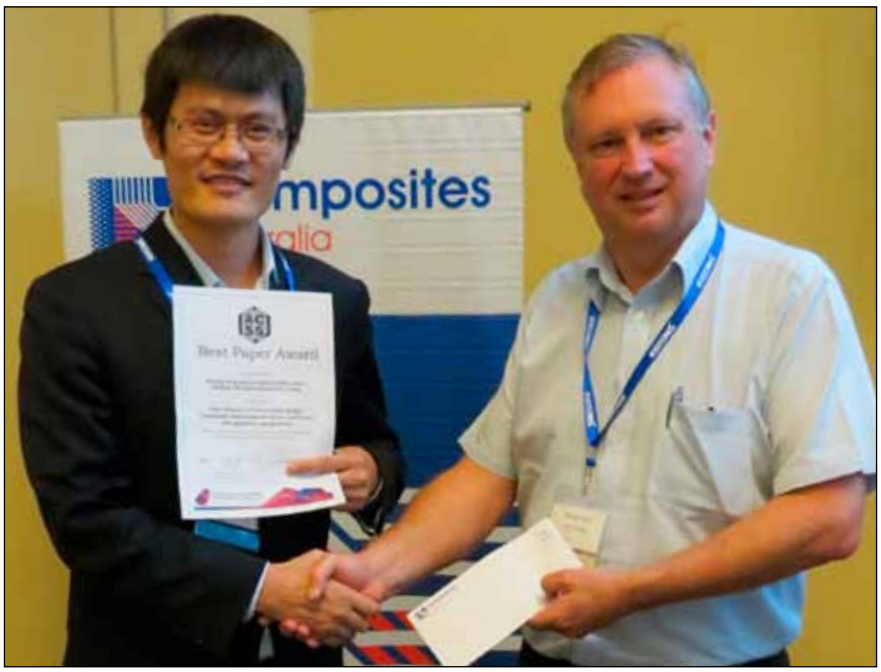
Peter's presentation to the conference described the process of developing this strategy, as well as the outcomes that were beginning to flow from having a coordinated approach. While the UK has a size and scale that we can only imagine in Australia, there is a lot that we can translate from this experience to our own context. It is not possible for universities to have depth of capabilities in every area and this is where having a coordinated strategic approach can be beneficial to everyone.

This is not a new conversation in the Australian environment. Most recently, Boeing Australia has catalysed the development of a research road map for composites starting with Victoria.

By understanding where each institution has depth in research capabilities, Boeing has been able to engage with universities in a far more effective way, and there's also a benefit for the universities. It has enabled us to collaborate far more effectively and to develop new coordinated research efforts that are inclusive and leverage our combined capabilities. It has provided a reminder that we need to collaborate to keep Australia on the world stage and to ensure that we can hold our own with European universities where the budgets for projects are an order of magnitude larger than ours. If we cannot compete on scale, then we need to be smarter and use our home advantage of working well in multi-disciplinary teams.

We have the perfect opportunity to showcase our capabilities on the world stage in 2019 when we host ICCM22, bringing around 2000 leading composites engineers and scientists to Melbourne in August. This is only the second time the premier conference for composites has been held in Australia, the first was in 1997 when Murray Scott, now Chairman of Advanced Composite Structures Australia, chaired ICCM11 on the Gold Coast. The global composite community will be coming to our doors. What better opportunity to represent ourselves as a unified sector where universities are supporting the growth of a vibrant composites industry?

Prof Murray Scott (ACS Australia) presents the 2017 Australian Composites Structures Society Best Paper Prize to Dr Chuang Feng from RMIT University.



CSIRO News

Australian carbon fibre production breakthrough

The "missing link" in Australia's carbon fibre production capability, a wet spinning line, has been installed the at CSIRO research facility on Deakin University's campus at Waurn Ponds, near Geelong Victoria.

Only a handful of companies around the world can create carbon fibre, each using their own secret recipe. To join this elite club CSIRO and Deakin researchers had to crack the code.

In doing so, using patented CSIRO technology, they've created what could be the next generation of carbon fibre that is stronger and of a higher quality.

Director of CSIRO Future Industries, Dr Anita Hill, said the joint facility enabled Australia to carry out research across the carbon fibre value chain: from molecules, to polymers, to fibre, to finished composite parts.

"Together with Deakin, we've created something that could disrupt the entire carbon fibre manufacturing industry."

The wet spinning line machinery (pictured) takes a sticky mix of precursor chemicals and turns it into five hundred individual strands of fibre, each thinner than a human hair. These are wound onto a spool to create a tape and taken to massive carbonisation ovens to create the finished carbon fibre.

CSIRO and Boeing sign $AUD35 million research agreement

In the latest step in a 28-year partnership, CSIRO and Boeing have announced a new five year $35 million research funding agreement with the focus on space sciences, advanced materials and manufacturing.

Over the years the organisations have invested more than $AUD170 million on 190 joint research projects into everything from innovative new manufacturing processes, to fire retardants, biofuels and software.

The partnership has delivered a range of innovative technological breakthroughs such as the simple and effective "Paintbond" technology that has been applied to more than a thousand Boeing airplanes, including new commercial aircraft delivered to both Qantas and Virgin Australia. The treatment is predicted to save millions of dollars in maintenance costs.

Australia hosts Boeing's largest research and development operation outside the United States.

"Our relationship is a real success story of science partnering with industry to create impact, and we're looking forward to growing that impact even further in the coming years," CSIRO Chief Executive Larry Marshall said at the May 2017 funding announcement.

CSIRO's "Paintbond" technology, has been applied to more than a thousand Boeing aircraft. It is predicted to save millions of dollars in maintenance.

More information: www.csiro.au

Vehicle manufacturer Tomcar Australia's vision for growth

An innovative Australian-made off road vehicle manufacturer is looking for an Australian supplier for its fibre glass components.

The Tomcar was initially developed for military use to be light and tough enough to be dropped into the field by plane and readily repaired and rebuilt in remote areas when damaged.

Weighing 700 kg and designed for safety and rough terrain, the Tomcar has a fully integrated safety shell, an extremely low centre of gravity yet high ground clearance. All parts are easily accessible, simple to fix and handy to replace with some crucial parts designed to fit both the left and right side.

The company has supplied vehicles to the Australian Air Force, outback cattle farms and rv enthusiasts.

Co-founder and chief executive David Brim now believes there is room to build off-road, zero-emission electric vehicles (EV) for mining companies.

"The Tomcar body is already tough enough, its fully welded metal and fibreglass, no plastic," Brim said.

"Where we can improve with the switch to electric cars is in the toughness of the battery and having a smaller motor with more power."

With the support of the CSIRO Kick-Start initiative, dollar-matched funding of up to $50,000, Tomcar Australia is engaging the CSIRO's manufacturing team for feasibility research for an integrated systems solution.

At the conclusion, the vehicle manufacturer plans to continue its collaboration with CSIRO in the development of prototypes and full production of Australia's first electric vehicle, forecasted for a 2018 launch.

Today the company is making one vehicle every four days at MTM Auto in Melbourne. David Brim says they are on track to double production by the end of 2017 and are looking to sell 10,000 vehicles.

The company sources almost 60 per cent of parts from local businesses but Mr Brim says it would like to increase that Australian content with a composite manufacturer.

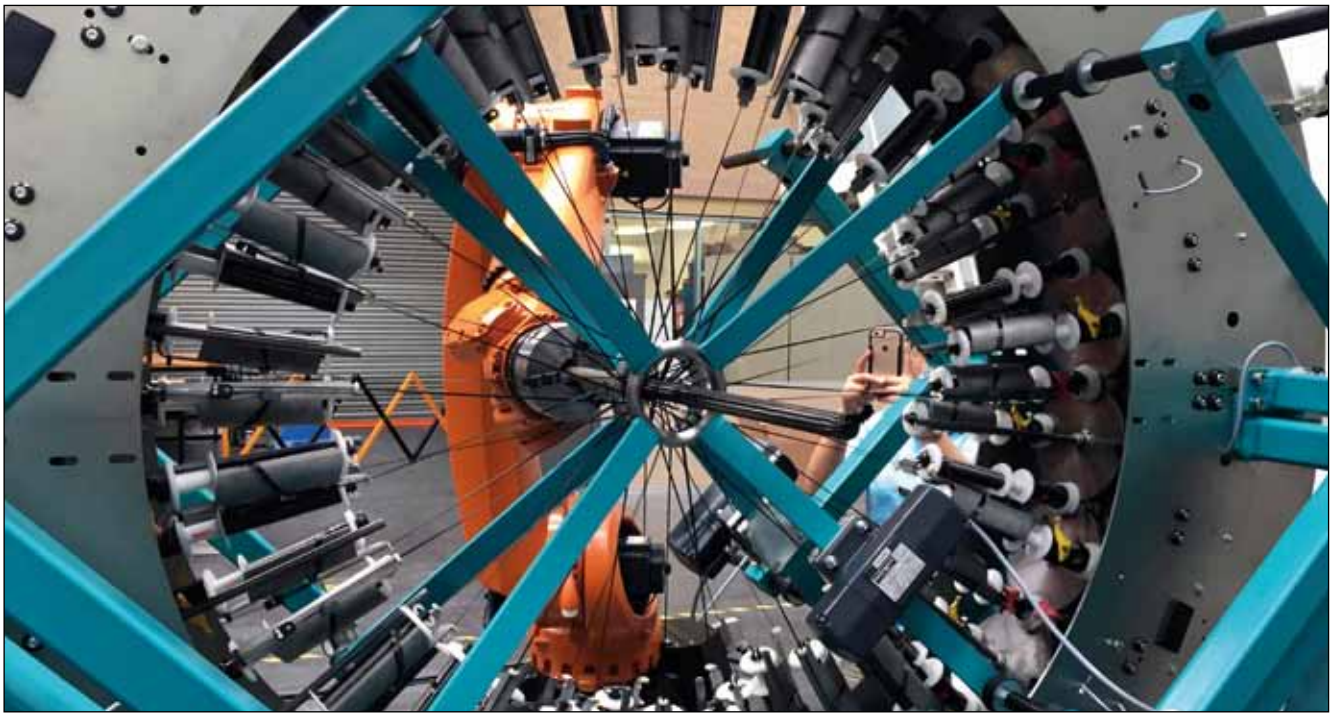
"The Tomcar's body panels are fibre glass, not plastic, because fibre glass is light, durable and fixable.

"We have started out importing the body panels from Mexico. We looked for an Australian supplier at the time but they could not come anywhere near the price, but now we are looking at bigger volumes it would be really good to have an Australian supplier on board."

Caption: Tomcar Australia co-founder and CEO David Brim wants to increase Australian content.

More information: Contact David Brim on 1800 866 227
www.tomcar.com.au

RMIT opens Australia's first automated radial braiding facility



RMIT University has opened Australia's first automated radial braiding facility enabling research into the creation of novel materials and shapes, not possible using other processing techniques.

"Australian researchers now have access to technology that supports high-speed, precision and versatility to radially braid single or multiple filament types including carbon, metal, optical, natural, bio-inspired and bio-compatible fibres and filaments to create new materials with unique functional properties," says Professor Adrian Mouritz, Executive Dean of RMIT's School of Engineering.

"With the capability to braid over multiple length scales spanning nanofibres to millimeter-sized filaments, the facility provides the opportunity to develop materials with multiple functional properties with potential uses spanning many industry sectors including aerospace, automotive, military, fashion and textiles, and medical implants and prosthesis.

"The facility will also allow researchers to design, synthesize and analyse new types of fibrous materials and open the opportunity for fundamental new scientific insights into advanced materials."

The technology was purchased with the assistance of an Australian Research Council grant of $240,000. While located at RMIT's Sir Lawrence Wackett Aerospace Research Centre, the technology will be accessed by researchers from universities across Australia for both pure and applied projects, including industry collaborations.

It is the second major investment in advanced materials technology for Australia, with the University of NSW opening the first automated composites manufacturing facility in early 2016.

Featuring automated tape laying and automated fibre placement capabilities the facility is opening international and domestic collaboration on projects in aerospace, marine, civil, renewable energy and primary resources for the UNSW School of Mechanical and manufacturing Engineering.

Events Schedule 2017

June

Wednesday 28th
Melbourne, VIC

Low cost integrated parts manufacture for transport
Hosted by Swinburne University's Factory of the Future this is an opportunity to hear from Prof Peter Middendorf, Director of the Institute for Aircraft Design at the University of Stuttgart and a co-founder of ARENA2036 –Active Research Environment for the Next Generation of Automobiles. The presentation will be followed by a tour of Swinburne's advanced manufacturing technologies, refreshments and networking.

July

Thursday 20
Coomera, QLD

Riviera Luxury Motor Yachts site visit and networking
Australia's most awarded luxury motor-yacht builder, Riviera, will open its doors to Composites Australia members for this site visit and networking event.

August

Tuesday 29
Perth, WA

Networking event: Urban Architecture
An evening networking function with light refreshments and finger food. Highlighting the successes and achievements in the Perth composites space of some notable composite sculptures.

October

Thursday 12
Sydney, NSW

Technology workshop: Adhesive bonding
This full-day course will be delivered by international composites engineering consultant Dr Rik Heslehurst.

November

Tuesday 28
Milperra, NSW

Ryman Composites site visit and End of Year networking event
Ryman Composites is an Australian owned family company that has been manufacturing fibreglass composites in Australia for 30 years. Owner Chris Ryman is generously opening the doors to his new composite manufacturing facility for members to come together to network and celebrate the achievements of 2017. Samples of product will be on display, including the innovative world-first flight simulator – the Synflyt.

For full details and to register go to. www.compositesaustralia.com.au/events

Disclaimer: This schedule was current at time of going to print but is subject to change. Composites Australia is not liable for any loss or expenses incurred due to changes in the program.

THE LEADING SOURCE OF COMPOSITES RAW MATERIALS

IMCD Business Group Plastics

Through our expanding partnerships with suppliers, we can offer an extremely comprehensive speciality composites product portfolio. In-depth knowledge of the composites production chain, innovative solutions at every stage of the process, technical expertise, market knowledge, and by building solid partnerships with you, we can ensure mutual growth. Contact us to find a stockist located near you.

IMCD Australia
P: +61 3 8544 3100, E: imcdpr@imcd.com.au, Customer Service: 1300 130 295
www.imcdgroup.com.au

IMCD

Value through expertise