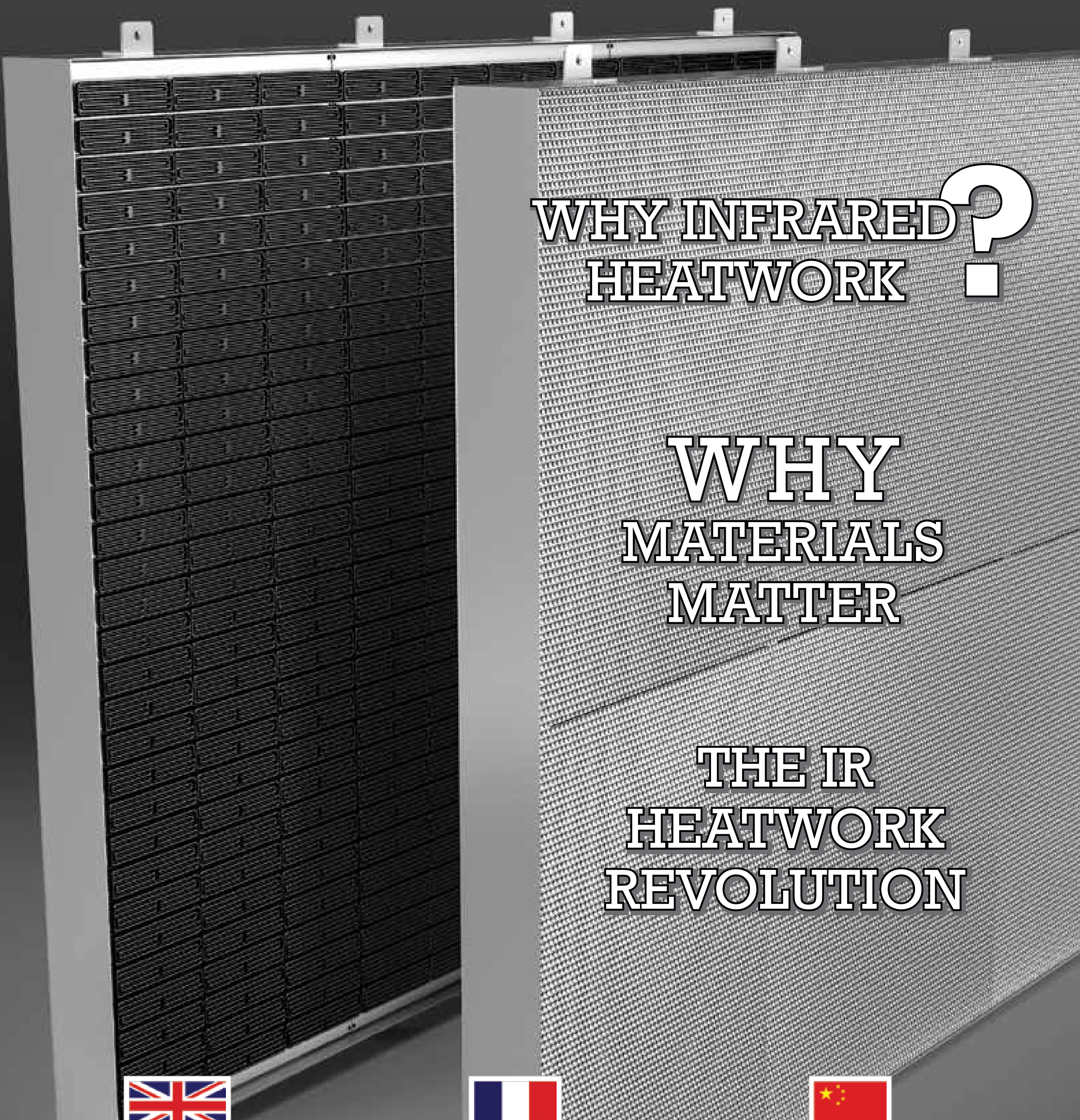
HeatWorks

HeatWorks 17 | May 2017 | www.ceramicx.com



WHY INFRARED HEATWORK?

WHY MATERIALS MATTER

THE IR HEATWORK REVOLUTION

COMPOSITES UK

REPORT FROM
JEC 2017

CHINAPLAS
16.17.18.19 MAY 2017 GUANGZHOU, PR CHINA

Composites – a new stage for Ceramicx IR heat work

Welcome to this our Composites-based edition of HeatWorks magazine.

Ceramicx is rightly excited about playing our full part in this dynamic industrial sector; as an exhibitor at JEC Paris Exhibition (March 14-16), as a builder of innovative Out Of Autoclave (OOA) machines and as a supplier of bespoke heat work solutions to all kinds of composite structure manufacturers – from boat builders to aircraft manufacturers.

The pages in this issue will provide outline articles on all the above topics and the coming months will provide an increasing amount of Ceramicx work and news in this area.

There is no doubt that our world stands in great need of the strength and cost savings offered by these lightweight and robust new materials. In my view the same can be said of the benefits offered by Infrared heat work of various kinds. In other words the two technologies are very well matched. Taken together, in fact, they promise exceptional growth, innovative new products, with more than a few surprises in store.

In addition, the confluence of both of these technologies offers tremendous environmental scope, chiefly in reducing energy cost, energy-per-part and carbon footprint.

Work for the composites processing industries ticks almost every box, commercial and technical, that today's Ceramicx has to offer. We are more than delighted to be involved and to be bringing our IR heatwork credentials to the composites table.

Dr. Cáthál Wilson
Director Ceramicx Ltd.

Contents

HeatWorks

Publication manager — Cáthál Wilson
cathal.wilson@ceramicx.co.uk

Editorial — Adrian Lunney
adrian@adrianlunneypr.com

Design and Production — David Hayward
david.hayward@ceramicx.com

Distribution — Orla Burke
orla.burke@ceramicx.com

Published by — Ceramicx Ltd.
sales@ceramicx.com

Are your contact details correct?

If not or you no longer wish to receive HeatWorks please email ***orla.burke@ceramicx.com***

Composites – the time for IR and Ceramicx has come

Dr Cáthál Wilson, Ceramicx Director, outlines the background to the Ceramicx first-time participation at the JEC Paris exhibition this March 14-16, and the launch of its Out Of Autoclave heatwork solutions.

Most people are now very familiar with the benefits of light-weighted plastic structures being used in aerospace, automotive and transportation generally.

The Boeing 787 contains over 50% advanced composites

Few realise that these are successes that are due to advances in composite materials manufacturing. And while their use is growing in these highly visible and publicised areas, a push is now clearly needed for the deployment of rapid manufacturing techniques. This is needed in order to fully integrate composites into mainstream manufacturing and away from the realm of the high end, high cost, specialist applications.

Such a move cannot be achieved without successful heatwork. It is into this space that Ceramicx is therefore launching its Infrared (IR) based heatwork solutions, including the Vector machine

The BMW i3 urban vehicle, for example, features a high volume production passenger cell made entirely from carbon fibre reinforced plastic (CFRP). BMW state this is a first for a high volume vehicle. Of critical importance in this switch to high volume production are the processing methods. This is where the advantages of smart infrared heating can become a key processing aid to the composites producer.

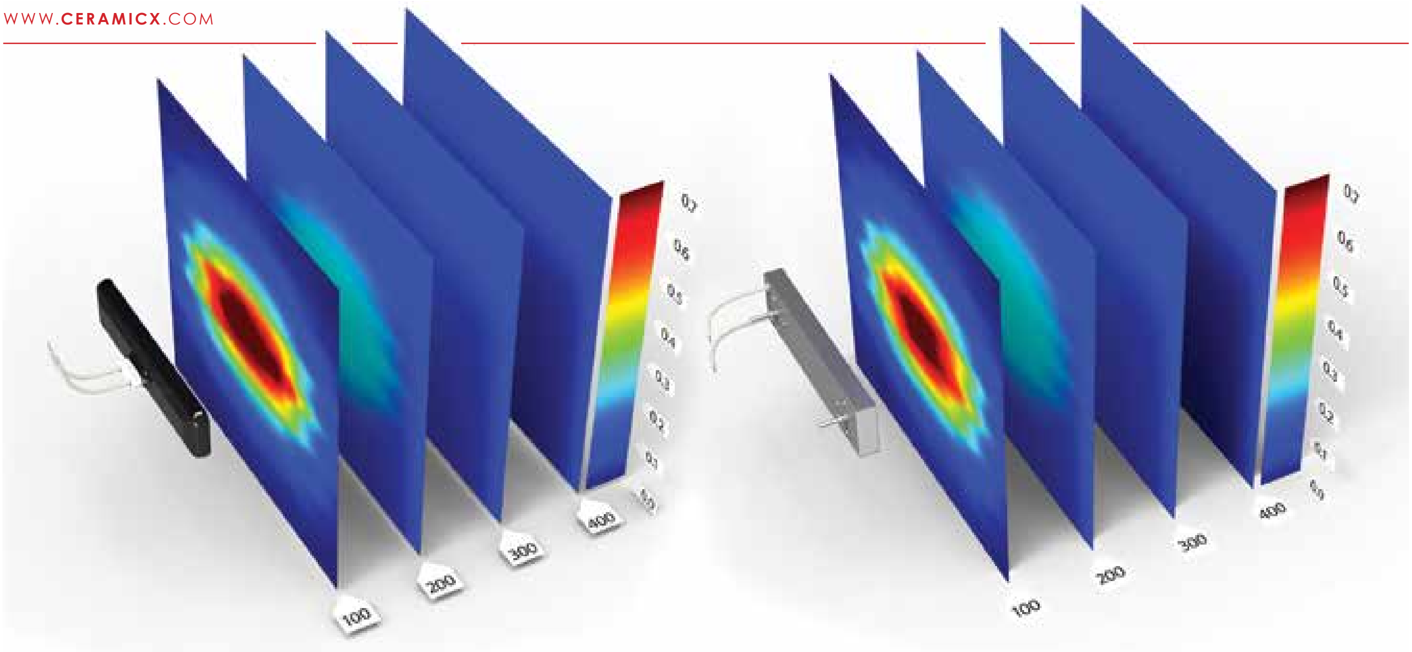
At Ceramicx we have been developing our infrared heating systems in order to play a major part in the targeted and focused delivery of Infrared energy for the curing of resins, preforming of parts, preheating of moulds or during intermediate material heating stages.

In almost any stage where thermal energy is required in the composite manufacturing process, Ceramicx can help formulate specific heatwork packages for company needs. Over the past twenty years Ceramicx has experience in the automotive, aviation and manufacturing sectors having worked with clients such as Rolls Royce, Aston Martin, Saint Gobain and Corning Glass. We have created custom infrared equipment for these clients in specialised applications. The Ceramicx Centre for Infrared Innovation (C^2I^2) is a further resource that has been established to help supply companies with heatwork solutions for their problems.

CERAMICX CENTRE FOR INFRARED INNOVATION

There are several reasons as to why these companies choose a Ceramicx system. Infrared-based heating has clear advantages over conventional oven and convective heating methods.

- Fast heat up and fast cool down times. Infrared can be switched on where and when it is required.
- High watt densities possible (*subject to material limits*)
- Higher production speeds
- Compact installations
- Low investment cost
- Adaptable and expandable
- May be the only option in some repair cases.
- Can penetrate into polymers giving a volumetric heating effect (*as opposed to conductive and convective heating*)



Energy intensity as a function of distance FFEH Full Flat Element Hollow with black glaze and FQE Full Quartz Element

When selecting an infrared emitter it is important to match the spectral absorption of the target material with the emitter. Many polymers absorb well in the mid to long wave regions. Although shortwave infrared heaters have the fastest heat up times, their high power density could lead to burning of the material surface.

A lower power heater such as a ceramic or quartz heater may provide a more gentle heat thus allowing time for heat to penetrate the material to effect a thorough cure. The nature of the process also needs to be taken into account, whether it is a continuous or discrete process. Impurities such as dust or vapour also can hinder the absorption of infrared by the target material and provision may need to be made for its extraction or removal.

The most basic control elements of infrared radiation are distance, power and time. A variable transformer can adjust voltage to the heater so as to vary the power. As radiative intensity drops with distance from the heater, the variables of distance from the heater as well as time exposed are used to control heating to the target material. However as this is an open loop system the possibility of either under cure or burning exists. A more preferable method is to incorporate non-contact thermometers to measure surface temperature and provide feedback to a controller unit which then regulates power to the heating elements. Depending on the complexity and size of the target component, several heating zones with individual temperature sensing and control can be used.

Thus, when designing an infrared heating system, the properties of the target material, the heater type, the operating environment and many other factors must all be considered before final element choice is made.

Radiant heat is of greatest benefit when used for the direct heating of a product. Infrared can be used in sheet forming of thermoplastic composites where a sheet of solid composite laminate is heated rapidly by infrared emitters and rapidly formed by pressing between two cooler tools which form the shaped mould. Such a process is associated with fast cycle times. For the three main types of heat curing resins used in composites (epoxy, phenol formaldehyde and urethane) infrared heating can offer a faster heating time, reduce the oven length, and increase line speed when compared with traditional convective heating ovens.

Infrared also finds use in tape laying. In this process a "tape" of the raw material is heated and deposited on top of a former. A high watt density infrared lamp such as a quartz tube heats the area forward of the tape lay down. A precision robotically controlled head allows high repeatability and control. Several components on the Airbus A400M and A340 are produced in this way.

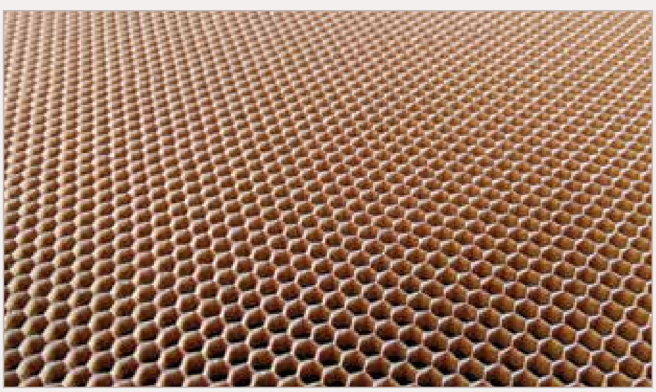
The preheating of moulds for composite production can also be performed by IR heating. The surface of the mould may have to be treated in some cases to achieve a suitable reaction with the IR, resulting in fast surface heat up times.

Repair operations on damaged composite structures such as an airplane fuselage provides us with another area in which infrared technologies are displacing conventional heating mats and conductive methods.

For irregular shaped components, infrared lamps can be designed which conform to the surface requiring the heat input. The repairs can be performed "in situ" and the curing apparatus is light, mobile, and doesn't require contact with the repaired surface.

Infrared heat sources are also desirable for a number of secondary processes in composites processing. The proper drying of fibres, for example, is a critical area: In pultrusion the fibres must be completely dry before the resin comes in contact with the polyurethane as excess water can cause blistering on the surface of the finished profile. Even moderate humidity levels can cause problems with certain fibres and polymer combinations. Infrared heaters are therefore an ideal method of treating the roving before pultrusion to flash off excess moisture.

Another intermediate stage in the processing of composite materials is de-bulking. In this process, the composite lay up is carried out in stages before final curing. During these intermediates stages, vacuum and moderate heat can be applied to reduce problems such as wrinkling and void formation.



Aramid honeycomb is used to as a core material in composite sandwich panels, aiming to increase stiffness with a minimal increase in weight.

Traditional curing methods have relied heavily on the autoclave, especially for high quality or safety critical items such as aircraft wings. Inside the autoclave, high pressures are utilised to produce components free of voids or defects, and convective heating generally provides the thermal energy requirement for curing. However the autoclave can be large, expensive to purchase and run. Cycle times are also high. With an interest in moving away from large costly autoclaves, more composite processes are being re-examined for completion "out of autoclave"(OOA).

As these methods are not in an enclosed chamber, conductive and convective methods of heat transfer are less suitable, and other forms of heating must be investigated. This is where the quick and directable advantages of IR can come into their own. This makes an IR system/oven IR is more suitable, as it can be smaller, lighter, controllable, cost effective, and targeted to the precise area.

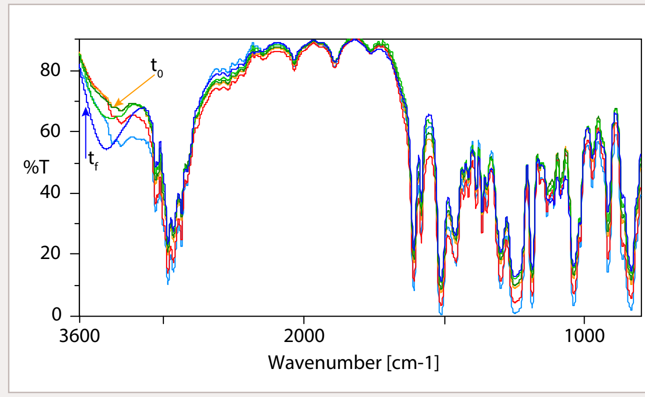


Fig 1. Change in spectrum of the mixture over time as shown, t_0 for initial time and t_f final time
(On-line monitoring of epoxy resin cure using infrared spectroscopy. F. Fouchal, J.A.C. Knight, P. Dickens, N. Garrington 2011)

It is interesting to monitor the cure of an epoxy resin as it happens. Figure 1 (adapted from Fouchal) shows the results of one such study. The troughs in the graph indicate the optimum wavebands for infrared absorption. For this particular epoxy, absorption is best in the 3 micron region and the 7-12 micron region. These samples are ideal for long wave infrared curing. It is noteworthy that the spectral absorption profile changes when the epoxy is cured, especially in the 3nm region where the absorption band differs indicated by arrows at t_0 and t_2. This could be of immense value in confirming the state of resin cure using non-contact methods.

Other articles in this issue will explore upcoming Ceramicx work in OOA production and our increasing work load in markets such as aerospace, marine, automotive and other places of composite production.

Please do not hesitate to contact us at

www.ceramicx.com

Carbon fibre / epoxy T sections are commonly used to stiffen thin structures such as wing skins. This image shows a twill weave sample.

Why Infrared heatwork ?

IR heating is mobile, rapid and flexible. It can be easily adapted to intermediate steps in the composites manufacturing or curing process, as well as deliver major savings in energy and curing time.

In one recent study IR curing resulted in a cure time of 56 minutes as opposed to 236 minutes for a normal "thermal cure" in an oven. This represents savings of 75%. The authors cited volumetric heating as a major factor in this fourfold increase, compared to a conventional heat which relied on thermal conduction through the epoxy and fibre matrix.

A further advantage of IR is that being a radiative source it requires no medium. IR should not be thought of as heat but as an electromagnetic wave which behaves in a similar fashion to light. Among other properties it can pass through a vacuum, and the heating source is non-contact, contamination issues such as dust - which may be a factor in convective heating - are non-existent.

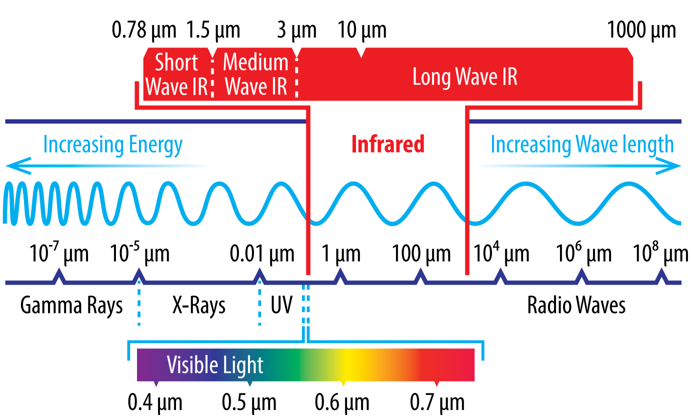


Fig 2. The electromagnetic spectrum (centre) showing visible light (bottom), and infrared (top) bands

In scientific terms, the Infrared spectrum is a form of electromagnetic wave or radiation which lies just between visible light and microwaves/radio waves. Infrared or thermal radiation is emitted from any surface whose temperature is greater than absolute zero (-273.15°C or 0 K). As the emitter temperature rises (in this case an emitter may be a ceramic heating element) the thermal energy excites the atoms and molecules within the heater resulting in the emission of photons. These photons are emitted from the surface of the heater in the form of infrared radiation. When these photons strike a material, molecular oscillations or vibrations are again set up thus causing the heating effect within the target material.

Some materials absorb infrared radiation well and heat up quickly, while other materials tend to reflect much of the radiation and thus remain relatively cool. In practice, a property called emissivity is a good guide as to whether a material will absorb or reflect infrared radiation. An ideal "black body" has an emissivity of 1, therefore materials with high values of emissivity (0.9-0.98) will absorb radiation and heat up quickly, while low values (0.02-0.1) are good reflectors and take longer to heat up. Many polymeric

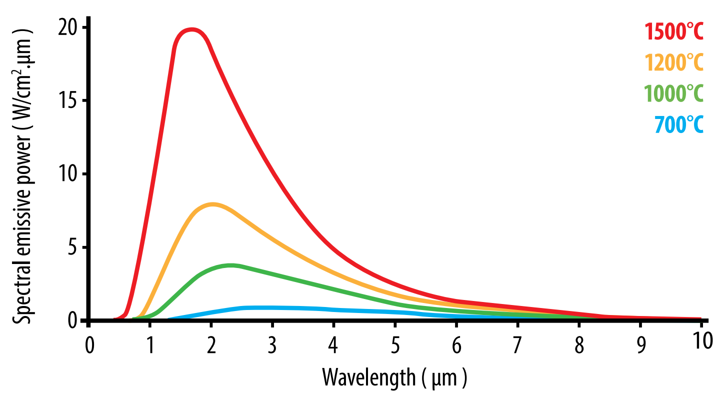


Fig 3. Planck Distribution showing the spectral emission plots from different emitter temperatures

materials readily absorb infrared radiation which is converted to heat rapidly within the material. Conversely, many metals especially when highly polished, absorb little radiation and are commonly used as reflectors.

As the IR emitter temperature rises, the wavelength of the emitted radiation decreases moving toward the short wave region closer to the visible light end of the spectrum. This explains why an object gets brighter with temperature.

Moreover, with this temperature increase, the amount of radiant energy emitted also increases to the fourth power of the emitter temperature. This can be explained by Plancks law and is seen in Figure 3.

For infrared heating, the commonly accepted wavelength bands are from 0.7 µm to 1 mm, however most infrared for industrial heating purposes occur within the range of 0.7 to 10 µm. This is often subdivided further into three groups, short wave IR, medium wave IR and long wave IR.

Shortwave IR is generally in the bands from 0.7 to 1.5 µm. A significant portion of this radiation will be bright light due to its proximity to the visible light spectrum. These heaters typically comprise a tungsten filament in a sealed glass tube filled with halogen gas. This allows the supported filament to reach temperatures as high as 2600°C (4712°F). The peak wavelength emitted is approximately 1 micron. This type of radiation is high energy and will result in fast heat up times. They are extremely penetrative and allow rapid on/off cycles.

Medium wave IR lies in the 1.5 to 3 µm wavebands. A typical medium wave heater may contain a tungsten filament in a porcupine wound or star type coil, which can be operated at temperatures up to 1500°C (2732°F), with peak wavelength emissions of approximately 1.6 microns. These reach top temperatures within seconds and have excellent structural rigidity. The coil is designed to minimize light output and maximize IR emission thereby increasing IR radiant efficiency.

Long wave IR lies in the 3.0 – 10 µm range. These can be ceramic heaters or quartz heaters. The ceramic heater comprises a coil of resistance wire placed within a clay mould which is then fired. A range of sizes and wattages determine the waveband of the infrared energy emitted, typically in the range of 2.0 to 10 µm. Although warm up times are longer than for tungsten type heaters, the elements are more robust and cheaper. Another type of long wave emitter is the quartz element featuring a resistance coil wound within quartz glass tubes. These have medium warm up times, and the useful emissive output is around 1.5 to 8 µm. Many polymeric materials absorb well in these wavebands.

JEC – leading the way

The JEC Company was created in December 1996 as a subsidiary of CPC, The Centre for Promotion of Composites, a non-profit association.

Over the past fifteen years, JEC has increased six-fold in scope, network and number of employees delivering a growing service to the composites sector. In addition to its headquarters in Europe (Paris, France), JEC opened offices in America and Asia. Its working Principle is the reinvestment of all income into the development of new products and services for the benefit of all players in the worldwide composites community.

JEC organizes JEC Europe Show in Paris – five times bigger than any other composites exhibition – JEC Asia in Singapore and JEC Americas in Atlanta and Boston, the Web Hub www.jeccomposites.com, the JEC Conferences, Forums and Workshops in Paris, Singapore and Boston.

In 2013, JEC estimates that the composites industry employed 550,000 professionals worldwide and generated 55 billion Euros worth of business

JEC supports the development of composite materials by fostering knowledge transfer and exchanges between suppliers and users. The JEC network connects more than 250,000 professionals from a hundred countries. A strongly user-oriented strategy JEC informs composite professionals about major events, economic, technical and technological developments, new products and applications. It provides the JEC publications – including strategic studies, technical books and the JEC Composites Magazine – the weekly international E-letter "World Market News" and the French E-letter "JEC Info Composites"

The IR heatwork revolution

Ceramicx exhibits at JEC 2017 in advance of completing a ground breaking Infra-Red (IR) curing machine for composites called 'The Vector'

The Vector is a result of the partnership between Belfast Metropolitan (Belfast Met) and Ceramicx. Findhan Strain, founder and owner of Comeragh Composites and consultant to Belfast Met here explains some of the issues involved in Infrared for composites.

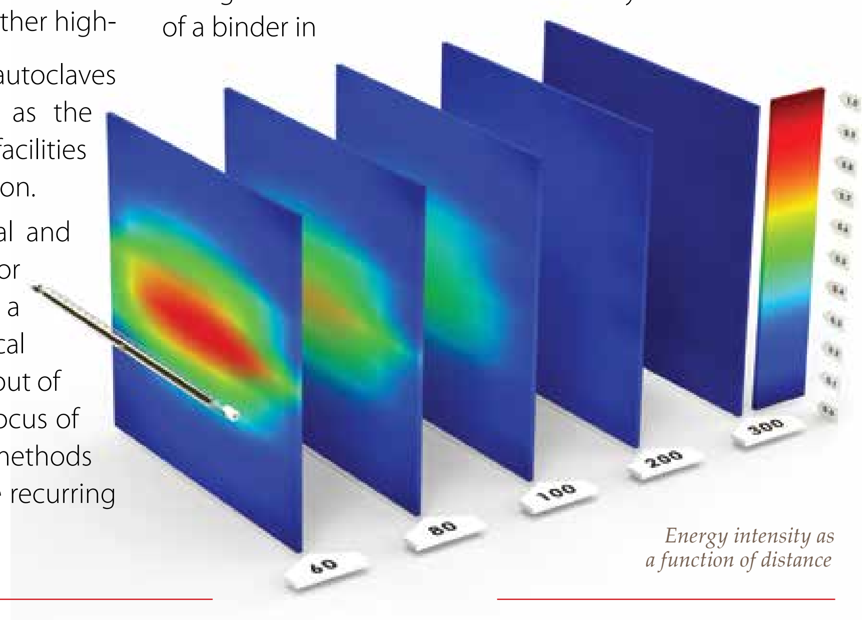
The autoclave at Belfast Met is capable of 250°C and 10 bar pressure and is used to manufacture high quality thermoset composites. The Vector machine is aiming to reduce capital costs, energy consumption, cycle time, floorspace and facilities integration costs associated with such autoclaves.

First, a little background: Autoclave ovens have been the staple of the aerospace, motorsport and many other high-value composites industries for years. However autoclaves contain a lot of complex sub-systems such as the vessel itself, the control systems, the complex facilities integration, cooling and air/nitrogen pressurisation.

All of these sub-systems lead to a high capital and recurring cost model that is not really viable for the future of the industry. In addition, such a model frequently presents a bottleneck in typical production. Consequently, the development of out of autoclave (OOA) methods has been a notable focus of the composites industry in recent years. OOA methods aim to remove the high capital expenditure, the recurring expenditure and the throughput limitations and focus on more modern approaches. Coupled together with advances in resin chemistry and a greater understanding of flow in pre-pregs for example, the future for autoclaves is looking bleak.

Even non-pressurised oven curing systems require a lot of unnecessary energy that heats the surrounding air, the walls of the vessel, any loading trolleys and the tool. Therefore, energy required to heat the actual component itself could be in the region of 20% of the overall heating energy. Infrared radiation heat sources, however, provided a much improved scenario. The requisite energy can be focused primarily at the component to be heated, greatly reducing the waste and cost associated with the process.

Infrared (IR) heat sources have been trialled in the curing of composite materials in the past but have primarily been limited to lab-scale equipment due to the complex nature of the heatwork and temperature distribution throughout the part. Useage has to date been limited mainly to the activation of a binder in



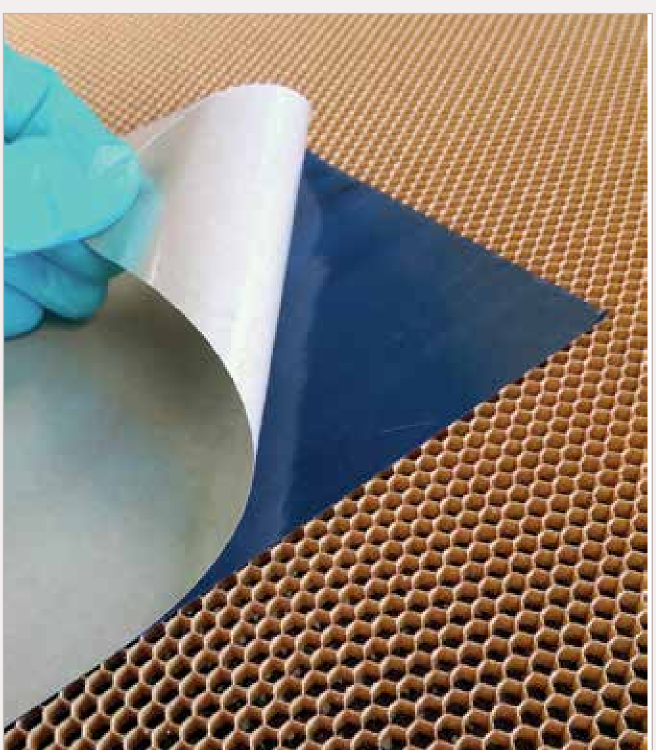
Energy intensity as a function of distance

The Vector drape forming machine, *see page 10 foe further details*

pre-forming of dry fibres in aerospace and other high value industries. In my opinion this is now all set to change with the development of The Vector.

The Vector represents a natural symbiosis between the IR heatwork specialisms at Ceramicx and the composites process understanding of Belfast Met.

Belfast Metropolitan College has extensive specialist experience in the manufacturing of advanced composite materials: The Composites Workshop at the e3 Building in West Belfast has been at the forefront of composites development in Ireland over the past number of years, focusing on product research and development, component manufacturing and process improvement. The workshop houses advanced manufacturing equipment ranging from a large autoclave to Resin Transfer Moulding capability, materials evaluation and of course, infra-red development machines.



A laminator places a small piece of uni-directional (UD) Carbon pre-preg onto aramid honeycomb

When this project commenced, we knew that existing IR machines had many flaws, most notably in the ability to efficiently transfer heat through the thickness of the part but also in aspects such as the ability to accommodate different geometries.

With many of these set-ups, a new part geometry could require days or weeks to validate the temperature profile. Our project therefore focused on addressing such issues which, in turn, led to the development of 'The Vector'.

Throughout the development phase, we looked at everything from the effectiveness of various heating system designs to vacuum membranes and machine footprint. The resulting machine is designed to provide a tailored solution to any composites heating problem.

Its notable advantages include:

- Efficient heat transfer to the part
- Low temperature differential throughout the part
- A minimalist shop floor footprint, reducing space and cost
- A low maintenance design
- A high quality vacuum system
- A reduction in drive complexities and associated vibrations compared to existing designs
- Ease of access to all sides

The unique aspect of this project is that Ceramicx understands the IR heatwork issues inside out. Ceramicx – via its Herschel machine test instrument - has the ability to map all aspects of the IR radiation field in 3D space, thus contributing a predictive foundation for the performance of the Vector machine.

Existing machines in the current marketplace tend to put a much greater emphasis on the machine itself and are less equipped to deliver on how the IR energy interacts with the material. Because of this project, Ceramicx are now able to not only provide an enhanced pre-forming service but can also provide a full resin curing solution. This is truly unique.

Why materials matter

It is typically said that composites comprise of two key elements, most notably the matrix and the reinforcement.

For the majority of thermoset aerospace structures, epoxy is the matrix of choice and carbon fibre is the reinforcement.

Compared to many other materials such as metallic where a material is given a physical shape from a billet, composites are unique as the process of combining these two materials influences the physical properties of the finished component as much as the individual constituents do.

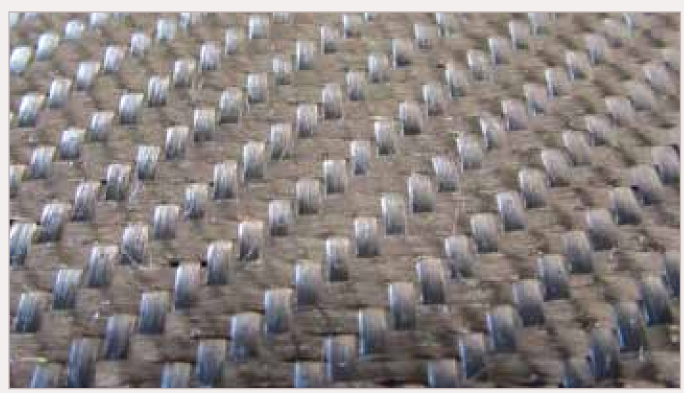
Storage, laminating, machining are all critical steps that influence the geometric shape and the physical properties of the finished part but the curing stage is perhaps the most critical aspect of the entire composites manufacturing process.

hardener or through the external application of heat but it is usually a combination of both. Simply put, aerospace epoxies are exothermic in nature but full cure is typically achieved by curing components in an oven.

Many carbon fibre epoxy composites used within the aerospace industry are cured in an oven or heated mould at 180°C/355°F to achieve a high glass transition temperature of the finished component.

A glass transition temperature higher than that which the component will experience in service is necessary to ensure that it will maintain its structural integrity throughout its operating range.

Dry Carbon – A twill woven carbon fibre cloth



A twill weave carbon fibre / epoxy pre-preg prior to lay-up

When referring to composites manufacturing, curing can be considered to be the steps that involve the change of the resin from a un-cured to a cured state.

The un-cured state can be a single component resin, a dual component resin or even a pre-catalysed resin in a controlled state. The manufacturer directly influences the physical properties of the composite by controlling the change of the resin into a fully rigid and structural part. Energy is required to cure such resins and this can be achieved through an exothermic reaction of the resin and

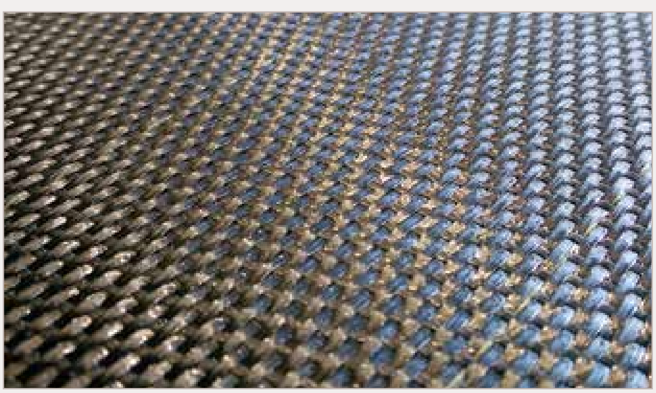
Additionally, curing at a temperature of this nature is necessary to ensure that the component will also maintain good physical properties when exposed to challenging environmental conditions such as 'hot and wet' conditions (80ºC and 90% RH) where functional glass transition temperature of the resin is reduced even further.

Consequently, typical epoxy resin systems on the market for aerospace structures cure at around 1800C. This has a huge knock-on effect on many other aspects within manufacturing, most notably cost.

Cutting Carbon – Dry carbon fibre cloth can suffer weave distortion during handling or high pressure resin injection in processes such as RTM or RTI. Pre-forming with Ceramicx IR machines prior to injection can reduce weave distortion and greatly enhance quality in aerospace composites.

For example, moulds need to be well designed to ensure that compatible values for Coefficient of Thermal Expansion (CTE) between tool and part are considered and resin shrinkage and inherent stresses are accommodated.

Another key factor in high temperature curing is the control of heating: In traditional ovens, heating coils will distribute heat through a combination of radiation and convection, heating the oven walls, the tool, any loading trolleys and finally the part itself.



Carbon fibre / epoxy pre-preg is a commonly used material within the aerospace industry. This image shows a typical '5 Harness' satin weave cloth prior to lay-up

This method means that a significant portion of energy is wasted as the only component that really requires heat is the resin in the part. Consequently, moulds are complex, heating costs rise, cooling times rise and cycle times rise, leading to an expensive manufacturing process. The use of Infrared radiation – as supplied through Ceramicx built systems and the new Vector oven - can greatly reduce all of these parameters as targeted heating of the part only is pursued.

Comeragh Composites

Findhan Strain owns Comeragh Composites, a specialist manufacturing consultancy business based in Belfast. He works as a consultant to Belfast Met and has extensive experience in the composites industry, from the manufacture of racing car chassis' to aerospace components to sporting products and everything in between.

Findhan Strain

Belfast Met

Belfast Met is the largest further and Higher Education College in Northern Ireland and one of the largest in the UK with enrolments totalling 37,000.

It has developed a dynamic new curriculum which mirrors the priority growth areas identified for Northern Ireland. Through partnerships with industry, it constantly adapts the curriculum to meet the skill demands of our economy.

The college has designed a portfolio of courses to address a variety of skill needs – from apprenticeship and Level 1 courses, to those undertaking degrees and post-graduate study.

The focus for the future is to support the development of Belfast by providing education, training and skills development to enhance individual, community and economic prosperity.

The College has built an excellent reputation with employers and is set to build on this by developing long-term mutually beneficial partnerships and being recognised as expert in key and emerging growth areas.

Coming soon – The Vector

Peter Marshall of Ceramicx explains how the new Infrared (IR) composites heating technology is grounded in making commercial advances and is set to reach an international marketplace that is ripe for change.

The Ceramicx Vector drape forming machine is designed to heat and cure carbon composite material whether its pre-preg or dry fibre. Ceramicx has applied its deep knowledge of the properties of infrared heating in order to revolutionise the heating of carbon fibre, optimising the balance between temperature, penetration, power and cycle time.

The Vector can also be customised to meet the customer's size requirements with no exclusive minimum or maximum dimensions for parts. The heaters are individually powered and controlled in zones by the ubiquitous Siemens HCS system in conjunction with calibrated optical temperature measurement. The feedback loop ensures that the part does not exceed the upper most cure temperature and that the temperature gradient through the part's thickness is as minimal as possible.

The Vector drape forming machine has no complex drive shaft systems, gear boxes or external motors. This reduces the vibrations on the heaters and the required maintenance on these parts. Moreover, floor space can be reduced as access is virtually all from beneath the superstructure.

The optimisation of the heating parameters also saves the Vector user time and money; ensuring that infrared radiation's properties and capabilities are exploited to best suit the materials, the application and the manufacturing process.

Additionally, multiple trolleys and vacuum systems can be supplied to further ensure that the process time is as minimal as possible giving the company greater economies to the user.

Future developments for the machine include optimisation of the pyrometers to incorporate live changes in emissivity of the over materials as well as calibration of the time required for the heat to traverse the thickness of the part.

These factors will combine in order to give the user a much greater understanding of the heating process and the complex heat transfer phenomena which occur during the process.

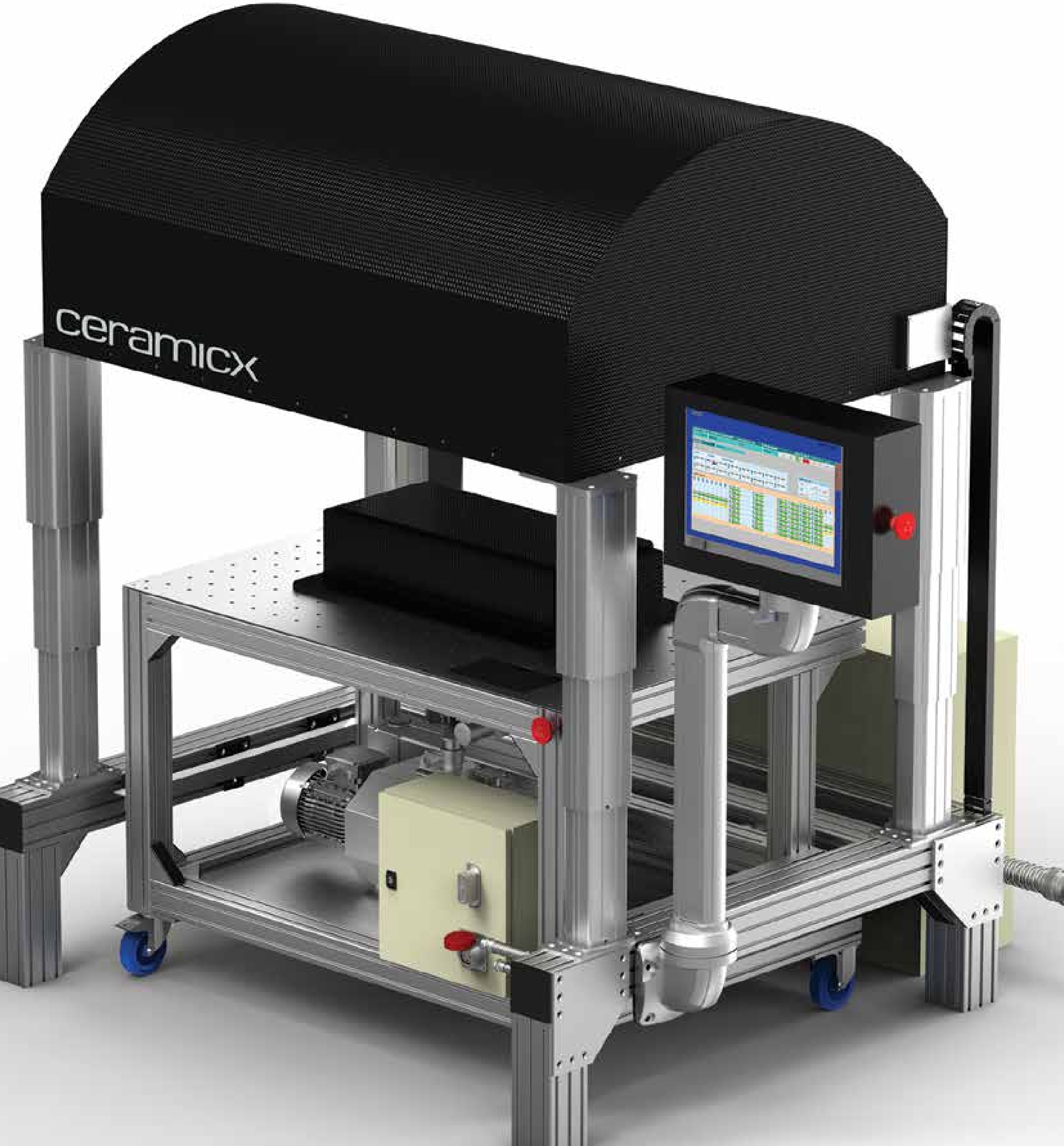
Investigations will also be made into the use of novel methods to characterise, reduce and/or eliminate the void content within the part. Research into this aspect will commence shortly.

The development of the Vector Drape former could not have been achieved without a close partnership with Belfast Metropolitan College. The college's vast experience of troubleshooting composite forming and process development is unrivalled. The project was also generously supported by InterTradeIreland's Fusion project. As testing and troubleshooting continues, Ceramicx will publish data, in the form of white papers, on the heating process for these carbon composite materials.

belfast met Composite Materials at Belfast Met

Simply pick up the phone or email to discuss your process and machine requirements.

- cathal.wilson@ceramicx.co.uk (Europe/North America/ROW),
- peter.marshall@ceramicx.com (Europe)
- brett.terbrack@wecointernational.com (North America)
- +353 28 37510


ceramicx

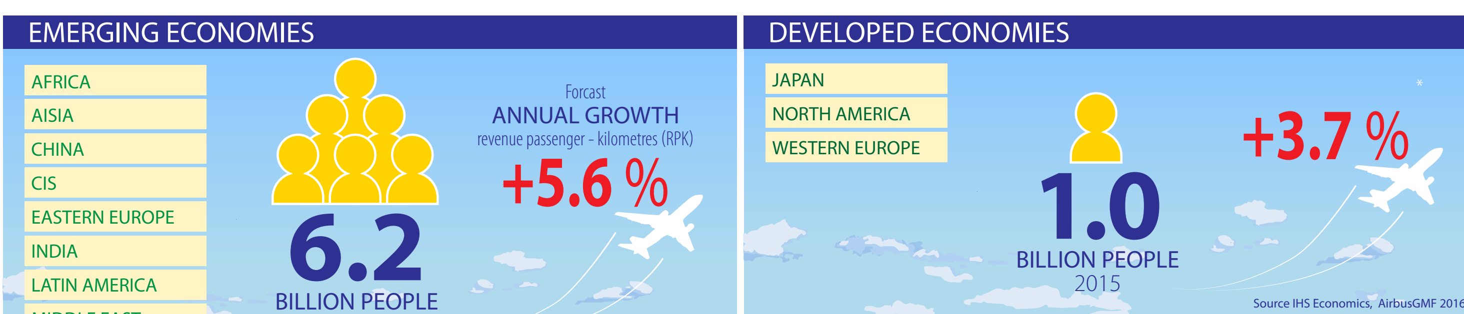
Flying high – Ceramicx in aerospace

Dr Cáthál Wilson, Ceramicx Director, reports from Rotherham UK where the latest Composites UK event was held – focused on the future of composite materials in the growing aerospace market.

The December 6th event was the first Ceramicx foray into a Composites UK organised event. The day's proceedings and the presentation content were both excellent. At the time of going to press Ceramicx has just attended our 2nd Composite UK event at AC Marine, Southampton, in order to learn more about marine turbine applications. Composites UK does a superb job in marshalling information and resources for the UK marketplace and Ceramicx looks forward to playing a full part in the organisation's future.

Whichever way you look at it, worldwide aerospace and worldwide aerospace composite structures are set for impressive growth. The only question is by how much?

Dr David Bailey, CEO of the Northwest Aerospace Alliance presented a compelling statistical picture of the growth in air traffic through all manner of global events in the past 60 years.



Air transport growth is highest in emerging economies

He predicts that Air Traffic will double within the next 15 years: Growth will be highest in emerging markets such as China, India, Asia, Africa and Latin America. Not only do these geographies account for 6.2 billion people in all, the market is also much less mature and has more growth potential than Western Europe, North America and Japan. Annual growth in these markets of 1.2 billion people is predicted at 3.7% - annual growth in the so-called BRICS grouping is seen as 5.6% - yielding many times more opportunities. As worldwide standards of living rise – so does the world stand in need of more aeroplanes; to the tune of some 33,000 new aircraft over the next 20 years. All of which, at least in theory, means good news for lightweight and efficient composite assemblies.

Composite materials, notes Bailey, have many virtues. They promise a decreased part count in aircraft (reducing the amount of fasteners for example) and also promise higher levels of reliability and better maintenance. However, he predicted some growing pains for the sector, most notably that aerospace composite repair would present a challenge for the sector.

David Phipps of Airbus predicts a slightly lower growth rate for the coming years with more than 32,600 new aircraft needed over the coming 20 years. Phipps pointed out that over the past 40 years Airbus has continually raised the composite content in successive generations of its aircraft. The A330, for example, had just 11% composite material content in its manufacture; today's A350 by way of contrast has a total of 53%.

The challenges of future growth, says Phipps, also represent the areas of highest opportunity for manufacturers. High levels of automation will be needed in order to meet future demand and the cost of manufacturing processes will need to be greatly reduced. Lower cost resins and fibres will also be in demand as will lower weight materials.

Mark Summers of the UK's Aerospace Technology Institute (ATI) also addressed issues of market outlook. The ATI is described as 'the objective convenor and voice of the UK's aerospace technology community. It is backed by a joint Government-Industry commitment to invest some £3.9 billion in the sector over the coming 13 years.

In the past 18 months the ATI has developed projects that will help to secure or grow some 40,000 jobs in the sector.

The ATI forecasts the future as delivering some $6.3 trillion worth of new commercial aircraft in 2016-2035. The ATI is accordingly backing four technology areas to help meet that demand; connectivity and electronics; propulsion of the future; aero structures of the future and future aircraft.

Summers noted the contribution of the High Performance Composite (HPC) Group to helping deliver aerospace results. The HPC is comprised of ATI, BAE Systems, NCC, DIT, Airbus and the UK Government's High Value Manufacturing catapult.

Clive Lewis offered some fresh statistical perspectives on the aerospace industry in his presentation, noting firstly that GDP growth drives traffic growth and that, in this regard, Asia Pacific will put on the most numbers in the coming years.

Short term, Lewis estimates that aerospace composites will enjoy at least 10% annual growth for the next 10 years. Wide body and narrow body civil aircraft will account for 80% of new build in the years up to 2035.

Clare Frias presented on behalf of our hosts for the day, the Advance Manufacturing Research Centre AMRC Composite Centre. She explained its place within Government structures and within the UK's High Value Manufacturing Catapult, which has 7 UK centres.

The AMRC has a bold strategic vision to develop a new campus and factory on the current site by the year 2050. The Composite Centre includes the processing, production and machining of carbon fibre composites and hybrid materials in its remit.

Centre services include; Advance curing technologies; Automated production; Novel Materials and processes and Dry fibre technologies

A very wide range of characterisation services are also offered by the Centre, including; Differential Scanning Calorimetry (DSC); Dynamic Mechanical Analysis (DMA); Thermo-Gravimetric Analysis (TGA); Rheometric Analysis; Infrared Spectroscopy; Microwave Reaction Systems; Pycnometer and Microscopy – Optical and SEM.

Excellent presentations from Composite Integration, M Wright and Sons and ElectroImpact rounded out a day that fully delivered a comprehensive picture of this growing and vibrant sector.

About Composites UK

Composites UK is the trade association for the UK composites industry. The association acts to encourage continuous growth and development of the industry, promoting the best practice use of composites materials. Its role is to bring companies throughout the supply chain together creating partnerships, as well as creating a unified voice to drive the industry forward, benefiting all of those involved.

The association describes a composite material as a combination of a matrix and a reinforcement, which when combined gives properties superior to the properties of the individual components.

In the case of a composite, the reinforcement is the fibres, which are used to fortify the matrix in terms of strength and stiffness.

The term 'composite' can be used for a multitude of materials. Composites UK uses the term composite, or reinforced polymers to encompass:

Carbon fibre-reinforced polymers (CFRP)	Glass fibre-reinforced polymers (GFRP)	Aramid products (e.g. Kevlar)

Bio-derrived polymers (or biocomposites as they are sometimes referred) The primary reason composite materials are chosen for components is because of weight saving for its relative stiffness and strength. For example, carbon-fibre reinforced composite can be five times stronger than 1020 grade steel while having only one fifth of the weight.

Stiffness and strength can also be influenced at the development stage. Composite material structures can be engineered so that the directionality of the reinforcement material is arranged so as to match the loading on a given component.

Ceramicx 4.0 - shaping the future

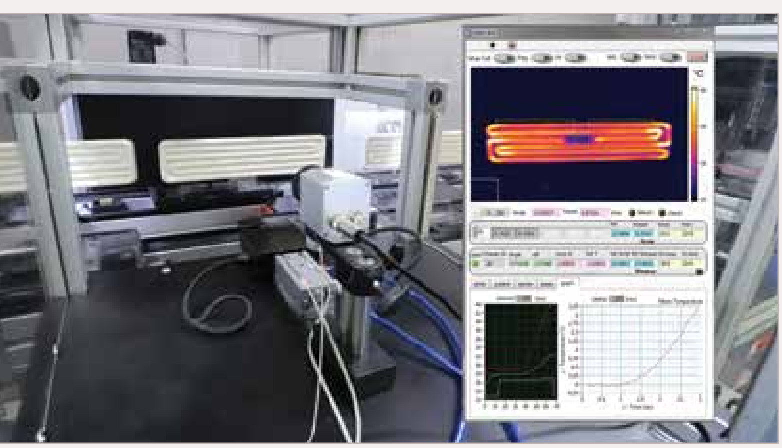
Dr Cáthál Wilson reflects on how Ceramicx is preparing for Industry 4.0 and the coming 4th Industrial Revolution

The term Industry 4.0 was first coined in Germany some five years ago. One way of expressing the 4.0 idea is that it stands for the synthesis and networking of all relevant technologies in a connected internet of objects, services and data.

For industry this means integrating, shaping and improving computing, electronics, manufacturing and web connectivity in order to be able to offer quick, flexible responses to customer demands; including cost-efficient production of small batches and unique items, such as body parts.

already; with automation and with the need for flexible manufacturing systems to tackle our various machine build needs. Being led by companies such as Seimens with products like Mindsphere (more in the next issue) and National Instruments through their Labview platform.

Indeed, areas of heat work in production and processing are likely to be key beneficiaries of Industry 4.0 as it develops, particularly as companies within the sector need to develop customized solutions and heat recipes for various needs.



The CIRCLE (Ceramicx Infrared Characterisation Laboratory Equipment) test platform has modular parallel test stations, each station has a dedicated controller with power, air, communication and IO connection. The stations are connected over a network and co-ordinated by a central computer.

The era of mass production previously organized by humans, lately using Lean Manufacturing programmes such as 6 Sigma and others is in fact coming to an end. It will be replaced by the intelligent, self-organizing factory that constantly reconfigures itself in order to answer the increasingly varied demands of the marketplace. Indeed, we are seeing signs of this in the Ceramicx workplace

Big Data will provide much common ground here – and as we at Ceramicx use our Herschel test instrument to build up a library of Infrared heating recipes and reactions with a variety of materials, so we shall have a much greater ability to predict, measure and more precisely configure a variety of heating systems for our customers. Those customers of ours who are 4.0 savvy will meet this trend and take it further; providing versatile manufacturing solutions for a much greater variety of need.

Industry 4.0 is arguably the biggest change in manufacturing for some time to come. It affects all key players in the supply chain - software, programmers, automation and machine builders, and materials suppliers.

Our first Ceramicx 4.0 project proper is located in our component testing facility: As readers will know, when you purchase any component from Ceramicx you reap the benefit and the legacy of our world-class testing and quality services.

We use a number of product testing methods – from fully automated to human-based spot checks. Now, with the assistance of Trinity College Dublin (TCD) Ceramicx is adding super computing power and Industry 4.0 methods to bring you products that will define our Infrared future.

The Big Data approach supplements our sensing and measurement capabilities. It comprises of hardware and software which takes the form of a number of custom-designed testing stations and cradles.

The new company capability, soon to be installed, is undergoing final trialling at TCD's Advanced Manufacturing Laboratories and is called CIRCLE – Ceramicx InfraRed Characterisation Laboratory Equipment infrastructure.

CIRCLE will give Ceramicx a world-class edge in creating new IR products, both standard and customized. CIRCLE will also provide Ceramicx customers with a unique, unrivalled and growing body of IR heating data – which can be shared and shaped with partners and customers to create new products, on a project by project basis.

Our project is transformational in that it brings extensive data into one cloud location. The location will cover all of the product features, and all of the product performance gathered during our manufacturing.

Having this data gathered from novel sensors and stored in the cloud allows for complex analytics to be used to characterise various aspects and influences on the component performance. The platform available through National Instruments has been a core enabler in the research work and this case will also be one of the first truly industry 4.0 examples for National Instruments.

An important and secondary aspect will be the ability of the test system to enable rapid up-scaling at the company. The system will be able to rapidly reconfigure from test to lab to production mode where batch sizes of one can be examined, rapidly accelerating product development cycles. The machine can scale to have additional test stations included, and can also be adapted to cover 95% of the product portfolio of Ceramicx.

Schematics of the data model are used, based on the ISA 95 enterprise control system. This contrasts with much typical manufacturing data which normally includes only elementary product status or elementary supply chain data.

- A robust scalable testing and research platform to accommodate existing and future testing needs
- Methodology to deliver consistent diagnostic data on a range of Ceramicx products
- Advanced test-data logging and storage capabilities that facilitate in-house data mining and analysis for R&D purposes (and will also enable Ceramicx to provide seamless data exchange with customers partners (internal/external)
- Software functionality to support diagnostic engineers and NOT data format expert (diagnostics oriented GUI)
- Ceramicx's capability to develop new products and optimise part & process design through improved visibility of significant input factors that contribute to process variation.

The key objectives in the first stage of the CIRCLE work will be to develop;

All of the innovation that CIRCLE delivers will undoubtedly support the emerging markets for Ceramicx IR heatwork in industry, especially aerospace and defence, packaging, and automotive and transport.

The current trend towards light weighting and metals substitution in manufacturing, for example, is creating a growth opportunity in the supply of IR heating solutions in polymer-based and carbon fibre manufacturing processes.

New IR heating product innovations by Ceramicx are how helping to facilitate moves by the automotive and aerospace industries towards producing mass volume body panels in carbon fibre materials. All of this and more will be helped and facilitated by the CIRCLE project.

We shall keep you informed of Ceramicx 4.0 as it develops.

Please do not hesitate to approach us at Ceramicx with your 4.0 news and views and any other matters that can help to keep us all aware and informed of this rapidly changing technology.

Composites UK Trade Association

Automotive sector showcase

Dr Cáthál Wilson

Composites UK is working alongside the Warwick Manufacturing Group (WMG) on an Automotive Sector Showcase. The event takes place on Thursday 11th May 2017, at WMG's International Digital Laboratory.

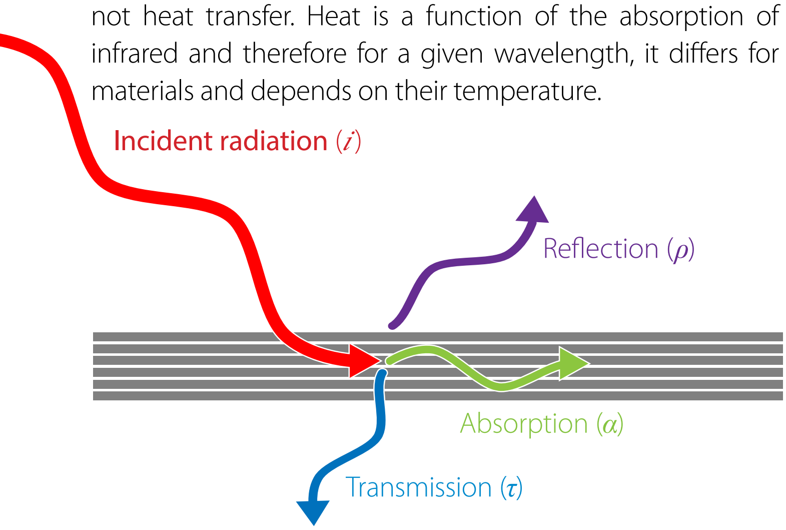
As members of Composites UK, Ceramicx is delighted to be spending time with the association at its annual conference and automotive showcase, May 10-11.

Ceramicx has a chance to work off a narrower composites niche; UK-specific and Automotive specific. I am personally very much looking forward to delivering a paper on an alternative to the autoclave to this audience, and also to manning our table top exhibition for the automotive sector on the following day.

Speakers for May 11 have been confirmed from Ford Motor Company, Jaguar Land Rover, Chomarat Textile Industries, Engel. Foseco International, Frimo, Mitsubishi Chemical Carbon Fiber and Composites GmbH, SHAPE Machining Oxford Advanced Surfaces and WMG

Infrared is gaining significant traction in the carbon fibre sphere as a fast, reliable and cost effective heating technology. Carbon fibre is an expensive material, however it offers the automotive sector a vital route to meeting emissions targets. Curing cycles can, in certain circumstances, be very protracted, but infrared radiation's fundamental properties help to address this.

Infrared's success lies in the fact that it's a method of energy, not heat transfer. Heat is a function of the absorption of infrared and therefore for a given wavelength, it differs for materials and depends on their temperature.



Reflectivity

Transmissivity

$$i = \rho + \alpha + \tau$$

Absorptivity

Incident IR has three key processes associated with it: reflection (ρ), absorption (α) and transmission (τ). In all heating cases, we're looking to minimise reflection and maximise the absorption, however for carbon fibre, we're looking for something slightly different as we need some transmission. Heating vacuum bags is useless, so we need to transmit though them to the composite. While we're looking to this, we also want heat the lower levels of the lay-up relying more on radiation than conduction. So we see that balancing the absorption and transmission properties is key to IR's success.

IR is a part of the electromagnetic spectrum and therefore behaves like light. It can be reflected, refracted and focussed but fundamentally, can only heat what it sees. Using these properties, IR can be given a directional quality that standard convection can't meaning reinforced part sections can have more energy applied to increase their heating rates and reduce the reliance of the curing process on conduction through the polymeric insulator.

The final advantage of IR is its control. Process temperature is controlled not based on the temperature of the air, but by the material temperature which can be logged. This can be done through contact and/or non-contact. Contact measurement devices such as thermocouples can be utilised in one or both of two ways – embedded in the tool beneath the part or placed in the part.

WMG THE UNIVERSITY OF WARWICK

Padraig Courtney

3D Limb heater on the way through Ceramfacturing

Ceramicx, hosted the pan European CerAMfacturing team responsible for developing the IR Limb Heater. The IR Limb Heater is part of a wider H2020-funded initiative involving the expertise of five different countries.

The meeting about the Limb Heater took place in the Ceramicx manufacturing facility in West Cork, Ireland. The Fraunhofer IKTS Institute in Germany is leading the project and the other companies involved in the heater are; Ceramicx, Hage and the University of Leoben with Eurogrant for dissemination and exploitation.

The intended use of the IR limb heater is in the treatment of physical ailments where heat is a known or possible remedy. Conditions such as rheumatism, arthritis, post-surgical healing are candidates for inclusion, where thermal treatment can be of benefit and muscle and fibre damage.

The heater is intended to be '3D printed' by the user and will be customised to the type of limb or the area of the body to be heated. The overall size of the heater and the shape of the heater will also be customised to the requirements of the individual.

The use of a non-contact infrared ceramic heater to heat a localized area is common place in industry and the IR Limb heater team believe that this same principal can be applied to the use of a ceramic heater to locally heat an area as required within the body.

The main work to date has been around the design of the heater, which is to be 3D manufactured with additive manufacturing. A design for a test product has been suggested and circulated and materials are also being trialed.

The coefficient of thermal expansion for the ceramic material and the resistance powder is currently being tested to ensure there will be not be mismatched materials and any undue stress within the final IR heater..

The University of Loeben are currently developing the ceramic feedstock for the 3D printer, which Hage has designed.

Padraig Courtney is coordinating the project work for Ceramicx. He says that 'Ceramicx was delighted to host the project meeting; to tour our EU partners around the IR heat technology in our factory and to also show them the excellent business facilities available in the Ludgate Hub in nearby Skibbereen.'

cerAMfacturing

Patrick Wilson

Ceramicx ready for CHINAPLAS 2017

The Chinese Plastics Industry is now a permanent part of the technical and marketing life at Ceramicx. Once again, Ceramicx Production Manager Patrick Wilson leads the Ceramicx marketing effort at the country's premier plastics exhibition.

No other annual exhibition event, in fact, is as important to Ceramicx as the Chinaplas show. The K Shows, Orlando exhibitions and others come and go every three years but Chinaplas demands the continuing commitment of Ceramicx each and every year – a commitment that we are happy to give.

Indeed, attentive readers of HeatWorks will know that Ceramicx researches and develops a range of products exclusively for the Chinese market. Last year, for example, I had the pleasure of bringing over a range of square ceramic hollow emitters specifically for Chinaplas 2016 the market in China. These sold very well and this year's exhibition will see us present at the Chinaplas show with a number of further innovations.

Our core business at Ceramicx is the design and manufacture of infrared heating components and systems for industrial and commercial use. We are unique in the supply world in that we make and supply world-class quality in all three kinds of IR components – ceramic elements, quartz elements and quartz tungsten elements. The Chinese appetite for all three kinds of quality emitter – and then some – is very healthy indeed.

Our quartz elements for example, continue to see significant technical development. We have created many different and bespoke sizes and over the 18 months or so we have also been asked to manufacture many custom ranges; small, long, wide, curved products.

The reason? 'A lot of our customers, Chinese users included, are looking to get a faster response from their heating processes; including an ability to exert much more control over cycle time and the heat process generally.

Our ability to be able to go from design to dispatch, regardless of global location and distance, is really fast. We build everything ourselves in-house and thus have much more control over the factors within the lead time. Again, these design and build factors are much appreciated at the Chinaplas exhibition.

Meanwhile our classic FTE, SFEH, FQE products that have been around for some years continue to be the "go-to" products for our customers – China included. They perform exceedingly well in very many applications and so many of our customers don't feel any need to change that.

It will be interesting to see if we can top the success of Chinaplas 2016: Last year we really wanted to demonstrate our cutting edge expertise in infrared heat technology

for the thermoforming equipment builders in that market. Machinery builders in China had shown a particular appetite for our Square Flat Hollow IR heating (SFEH) element and so we recognised that demand and created a new ceramic heating element for that part of the plastics industry there.

The Ceramicx SFEH-LN was the result; a new product launch, that was designed and made specifically for the Chinese market. The SFEH-LN comes in 2 wattages, 400W and 650W with ring terminals.

The Chinaplas reception to our new product was really outstanding; giving our customers significant cost savings in overall thermoforming machine-build. 2016 was our most successful year to date, with growth in all of our product areas.

Once again I am looking forward to working in person with our trusted agents and representatives at Chinaplas in the service of the Chinese market.

Xu Shan and the Ceramicx China team. Guangzhou Salaimi Automation Equipment Co. Ltd. (GSAE) lead the way: GSAE was established some five years ago and represents Ceramicx for product sale and service works in China, including Taiwan, Hong Kong and Macao. GSAE has succeeded in further penetrating the geographical Chinese territories of Guangzhou, Beijing, Shanghai,Qingdao; Shantou and Taiwan.

GSAE continues to invest in its people, infrastructure and market penetration, increasing the opportunities for Ceramicx products in the market. The company is extremely focused on introducing advanced IR technology and IR technical application level to these markets, deploying its own matrix of QSPT principles: Q-quality, S-Service, P-price, T-time.

When it comes to China there can be no substitute for 'feet on the street' and Ceramicx is happy to step up to that role. The Chinese industry continues to look for ways to improve its thermoforming efficiency and to purchase new products for reducing costs for thermoforming. This dovetails perfectly with our ambition at Ceramicx and the Chinaplas show is a perfect place for the match to happen.

Chinaplas 2017 is the 6th successive Chinaplas exhibition, organized with local partners GSAE and hosted in the British Plastics Federation pavilion at the show.

With every passing year Ceramicx increases its product range and its volume sales throughout the Chinese market. We are more than happy to be there.

16.17.18.19 May 2017

CHINA IMPORT & EXPORT FAIR COMPLEX
PAZHOU, GUANGZHOU, PR CHINA

THE ANNUAL CHINAPLAS EXHIBITION GOES ON BREAKING RECORDS;

2016

The 30th CHINAPLAS was held in Shanghai and broke records in this year

240,000+

Exhibition area m^2

3,335

Number of exhibitors

39 Exhibiting countries

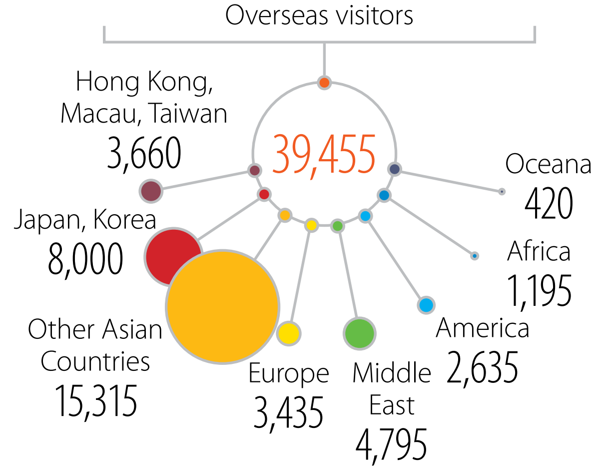
13 Country pavilions

148,575

Number of visitors

39,455

Overseas visitors



From **162** Countries

The 31st edition of the show is once more in Guangzhou.

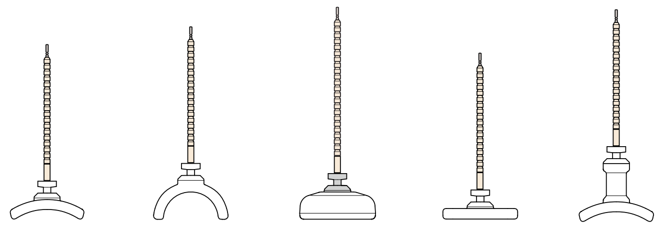
Last time here, 20-23 May 2016, the show broke a visitor record – totalling a footfall of 128,264 visitors with more companies showing their wares than ever before.

This year's theme is 'Intelligent Manufacturing, High-tech Materials, Green Solutions' and has three large concurrent events running during the exhibition

- The 2nd Industry 4.0 Conference
- Design X Innovation Conference
- 3rd Medical Plastics Conference

Product Guide

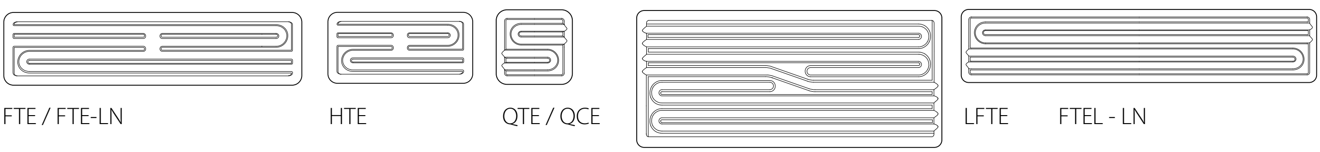
The full product guide can be viewed on line or downloaded from www.ceramicx.com/catalogues1/
or if you would prefer a hard copy, email a request with your details to david.hayward@ceramicx.com.



Trough Curved Hollow Flat Pillared Trough

CERAMIC TROUGH ELEMENTS

www.ceramicx.com/trough-elements/

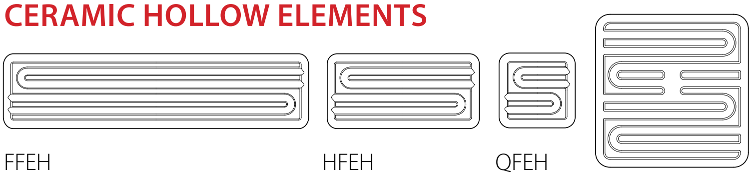


FTE / FTE-LN HTE QTE / QCE LFTE FTEL - LN

FTE Full Trough Element	245 x 60 mm	150W 250W 300W 400W 500W 650W 750W 1000W
HTE Half Trough Element	122 x 60 mm	125W 150W 200W 250W 325W 400W 500W
QTE Quarter Trough Element	60 x 60 mm	125W 250W
QCE Quarter Curved Element	60 x 60 mm	150W 250W
LFTE Large Full Trough Element	245 x 110 mm	1000W 1500W
FTE-LN Full Trough Element -Long Neck	245 x 60 mm	250W 400W 500W 650W
FTEL-LN Full Trough Element Long - Long Neck	285 x 60 mm	1000W

CERAMIC HOLLOW ELEMENTS

www.ceramicx.com/hollow-elements/

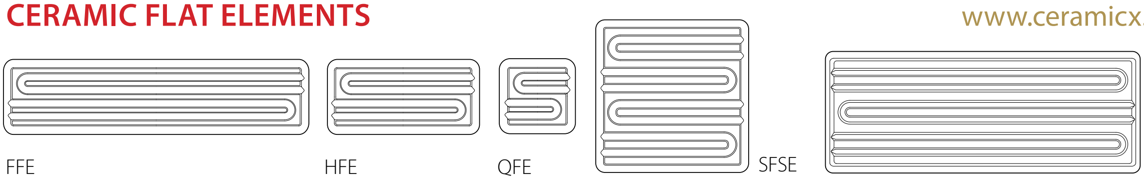


FFEH HFEH QFEH SFEH

FFEH Full Flat Element Hollow	245 x 60 mm	250W 400W 500W 600W 800W
HFEH Half Flat Element Hollow	122 x 60 mm	125W 200W 250W 300W 400W
QFEH Quarter Flat Element Hollow	60 x 60 mm	125W 200W
SFEH Square Flat Element Hollow	122 x 122 mm	250W 400W 500W 600W 800W

CERAMIC FLAT ELEMENTS

www.ceramicx.com/flat-elements/

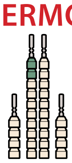


FFE HFE QFE SFSE LFFE

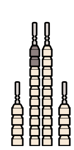
FFE Full Flat Element	245 x 60 mm	150W 250W 300W 400W 500W 650W 750W 1000W
HFE Half Flat Element	122 x 60 mm	125W 150W 200W 250W 325W 500W
QFE Quarter Flat Element	60 x 60 mm	125W 250W
SFSE Square Flat Solid Element	122 x 122 mm	150W 250W 300W 400W 500W 650W 750W
LFFE Large Full Flat Element	245 x 95 mm	150W 750W 1400W

THERMOCOUPLES

www.ceramicx.com/thermocouples/



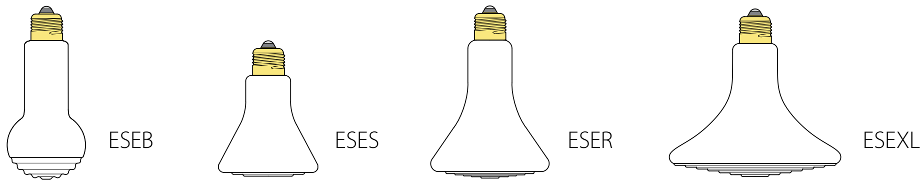
Thermocouple Type K
+ Nickel Chromium
- Nickel Aluminium



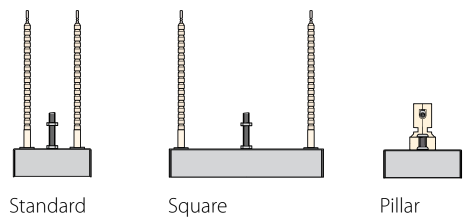
Thermocouple Type J
+ Iron
- Copper Nickel

EDISON SCREW ELEMENTS

www.ceramicx.com/ceramic-bulbs/

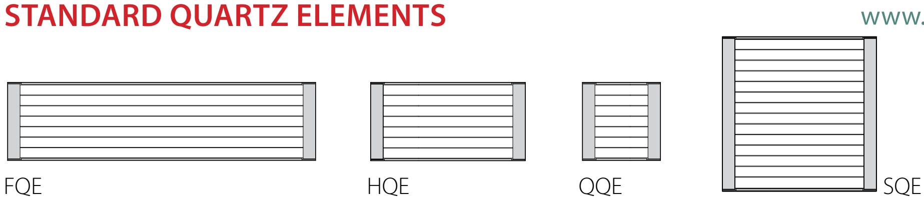


ESEB Edison Screw Element Ball	Ø65 x 140 mm	60W 100W
ESES Edison Screw Element Small	Ø80 x 110 mm	100W
ESER Edison Screw Element Regular	Ø95 x 140 mm	150W 250W
ESEXL Edison Screw Element Extra Large	Ø140 x 137 mm	400W



STANDARD QUARTZ ELEMENTS

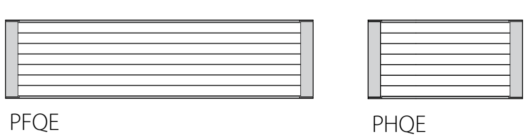
www.ceramicx.com/standard-quartz-element/



FQE Full Quartz Elements	247 x 62.5 mm	150W 250W 400W 500W 650W 750W 1,000W
HQE Half Quartz Element	124 x 62.5 mm	150W 250W 400W 500W
QQE Quarter Quartz Elements	62.5 x 62.5 mm	150W 250W
SQE Square Quartz Element	124 x 124 mm	150W 650W 1,000W

PILLARED QUARTZ ELEMENTS

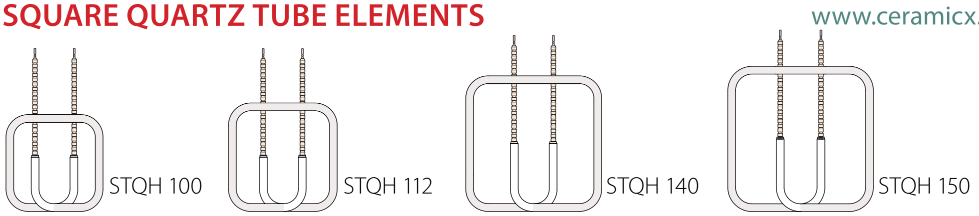
www.ceramicx.com/pillared-quartz-elements/



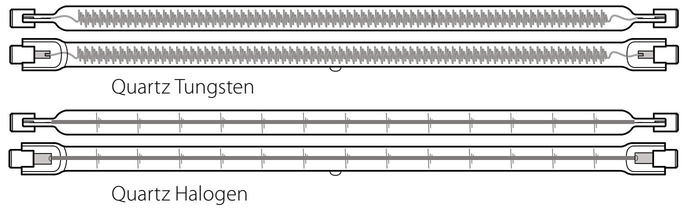
PFQE Pillared Full Quartz Elements	247 x 62.5 mm	150W 250W 400W 500W 650W 750W 1,000W
PHQE Pillared Half Quartz Element	124 x 62.5 mm	150W 250W 400W 500W

SQUARE QUARTZ TUBE ELEMENTS

www.ceramicx.com/quartz-square-tube-elements/

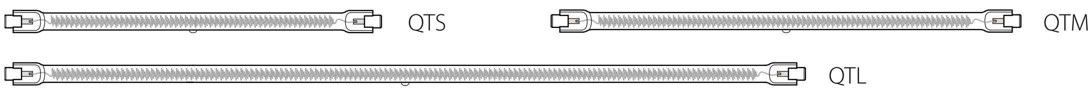


STQH100 Square Tube Quartz Heater	100 x 100 mm	150W - 400W
STQH112 Square Tube Quartz Heater	112 x 112 mm	150W - 400W
STQH140 Square Tube Quartz Heater	140 x 140 mm	150W - 650W
STQH150 Square Tube Quartz Heater	150 x 150 mm	150W - 650W



QUARTZ TUNGSTEN TUBES

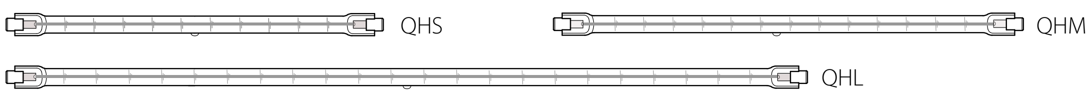
www.ceramicx.com/fast-medium-wave-emitters1/



QTS Quartz Tungsten Short	Ø10 x 244 mm	750W
QTM Quartz Tungsten Medium	Ø10 x 277 mm	1000W
QTL Quartz Tungsten Long	Ø10 x 473 mm	1500W 1750W 2000W

QUARTZ HALOGEN TUBES

www.ceramicx.com/short-wave-emitters/

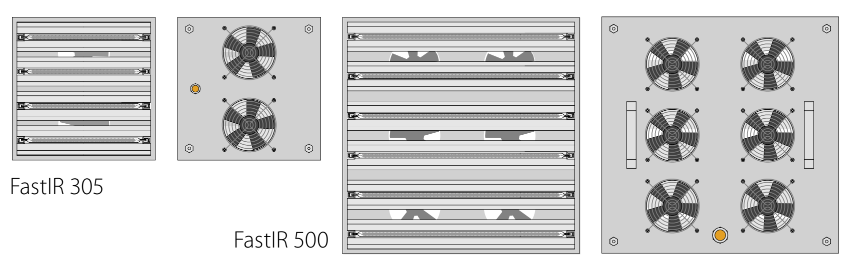


QHS Quartz Halogen Short	Ø10 x 244 mm	750W
QHM Quartz Halogen Medium	Ø10 x 277 mm	1000W
QHL Quartz Halogen Long	Ø10 x 473 mm	1500W 1750W 2000W

SPECIAL TUBE ORDERS

www.ceramicx.com/special-tube-orders/

Ceramicx can supply other types of Halogen/ Tungsten elements, of varying design, dimensions, length, coatings, terminations and electrical rating.

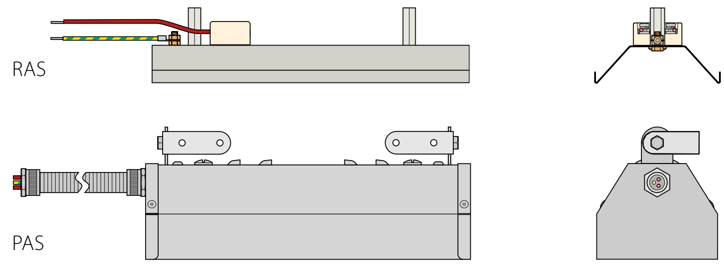


FAST IR

www.ceramicx.com/fastir-systems/

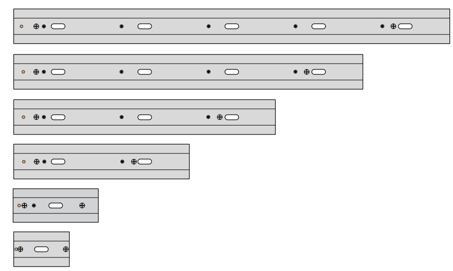
FastIR 305 — 305 x 305 x 150 mm — **4 Tube** 4kW — **5 Tube** 5kW
Suitable for 1000W Quartz Tungsten/Halogen Heaters QTM/QTH *(tubes sold separately)*

FastIR 500 — 500 x 500 x 150 mm — **6 Tube** 12kW — **7 Tube** 14kW
Suitable for 1000W Quartz Tungsten/Halogen Heaters QTL/QTL *(tubes sold separately)*



REFLECTORS

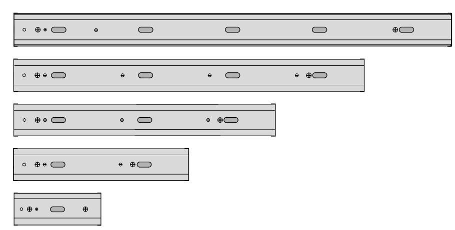
RAS 5	Reflector Aluminised Steel 5	1,254 x 100 mm
RAS 4	Reflector Aluminised Steel 4	1,004 x 100 mm
RAS 3	Reflector Aluminised Steel 3	754 x 100 mm
RAS 2	Reflector Aluminised Steel 2	504 x 100 mm
RAS 1	Reflector Aluminised Steel 1	254 x 100 mm
RAS 0.5	Reflector Aluminised Steel 0.5	160 x 100 mm



PROJECTORS

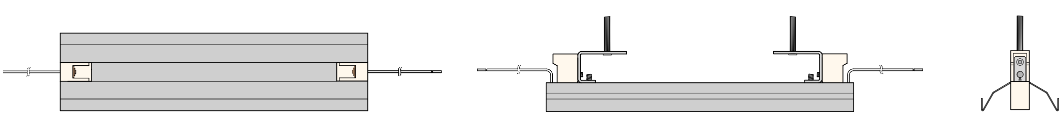
www.ceramicx.com/projectors/

PAS 5	Projector Aluminised Steel 5	1,258 x 94 mm
PAS 4	Projector Aluminised Steel 4	1,008 x 94 mm
PAS 3	Projector Aluminised Steel 3	758 x 94 mm
PAS 2	Projector Aluminised Steel 2	508 x 94 mm
PAS 1	Projector Aluminised Steel 1	258 x 94 mm



QUARTZ TUNGSTEN/HALOGEN REFLECTORS

www.ceramicx.com/reflectors/



QTSR	Quartz Tungsten/Halogen Short Reflector	250 x 62 mm	Suitable for QTS/QHS, *(Tubes supplied separately)*
QTMR	Quartz Tungsten/Halogen Medium Reflector	300 x 62 mm	Suitable for QTM/QHM, *(Tubes supplied separately)*
QTLR	Quartz Tungsten/Halogen Long Reflector	497 x 62 mm	Suitable for QTL/QHL, *(Tubes supplied separately)*

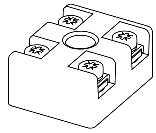
CUSTOM PANEL HEATERS.

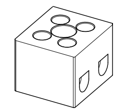
Available with anodised aluminium or ceramic glass face.
Range of Wattages and Voltages.

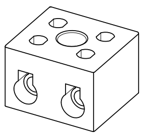
Anodised aluminium face - Good radiant efficiency, very robust, surface sheet can be easily cleaned or replaced if damaged by molten material.

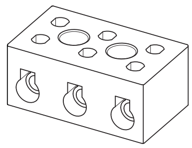
Glass ceramic face - Very good radiant efficiency, high percentage transmission of radiant output in medium to short wave range, surface can be easily cleaned.

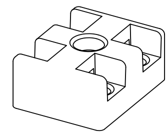
Electrical terminations Open 2P terminal block, Terminal block with cover, M6 or 1/4" threaded stud, Type K thermocouple with fixed high temperature socket and removable plug.

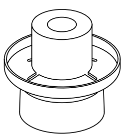
2P Ceramic Terminal Block *

Stainless Steel Fittings
40 x 32 x 20 mm

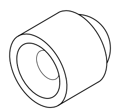
2P Mini Ceramic Terminal Block *

Nickel Galvanised Brass Inserts, Zinc-plated Steel Screws
21 x 18 x 15 mm

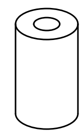
TB2 Ceramic Terminal Block *

(closed)
Plated Brass Inserts, Nickel Galvanised Screws
34 x 30 x 22 mm

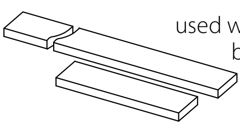
TB3 Ceramic Terminal Block *

(closed)
Plated Brass Inserts, Nickel Galvanised Screws
51 x 30 x 22mm.

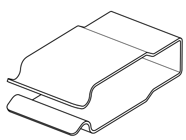
2P Ceramic Terminal Block *

no Fittings
40 x 32 x 20 mm

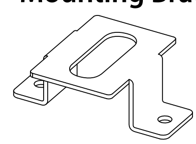
Ceramic Grommet and Starlock Fastener Set

100 sets per pack - used as an Insulator in sheet metal with 6mm hole
21 x 18 x 15 mm

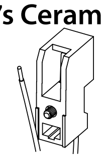
Ceramic Beads

per kg
Loose or Strung
Ø5 x 6 mm
4.5 mm to shoulder

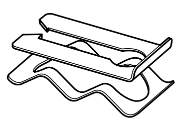
Ceramic Tubes

Ø5 x 11 mm

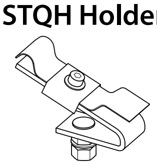
Stainless Steel Buzz Bar

used with the ceramic terminal block to produce a flexible power distribution system
8 x 2 x 1000 mm

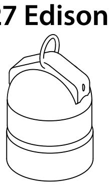
Flat Ceramic Base Holder

For Halogen/Tungsten heaters fitted with flat ceramic base

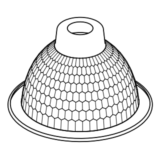
Mounting Bracket

For ceramic elements
72 x 57 x 28 mm.
slot size 42 x 15 mm

R7s Ceramic Holder

For Standard Quartz Tungsten/Halogen Tubes

Steel Wave and Spring set

Used in the mounting and installation of all Ceramic elements and the Pillared Quartz elements

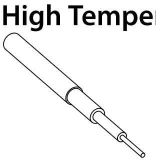
STQH Holder

For all types of square tube Quartz Heaters (STQH)

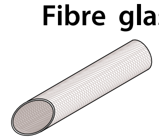
E27 Edison Bulb Holder

High temperature porcelain holder used with ceramic IR bulbs
Ø46 x 64 mm

Ceramic Bulb Reflector

Highly polished reflector for use with ceramic IR bulbs
Ø220 x 110 mm

E27 Bulb Holder with Base

High temperature porcelain holder used with ceramic IR bulbs
Ø78 x 60 mm

High Temperature NPC Cable

Single Conductor Cable, Flexible Nickel Plated Copper Core, Glass Fibre Insulation, Silicone Coated Fibreglass Braid
0.75 mm, 1.5mm, 2.5mm, 4.0mm

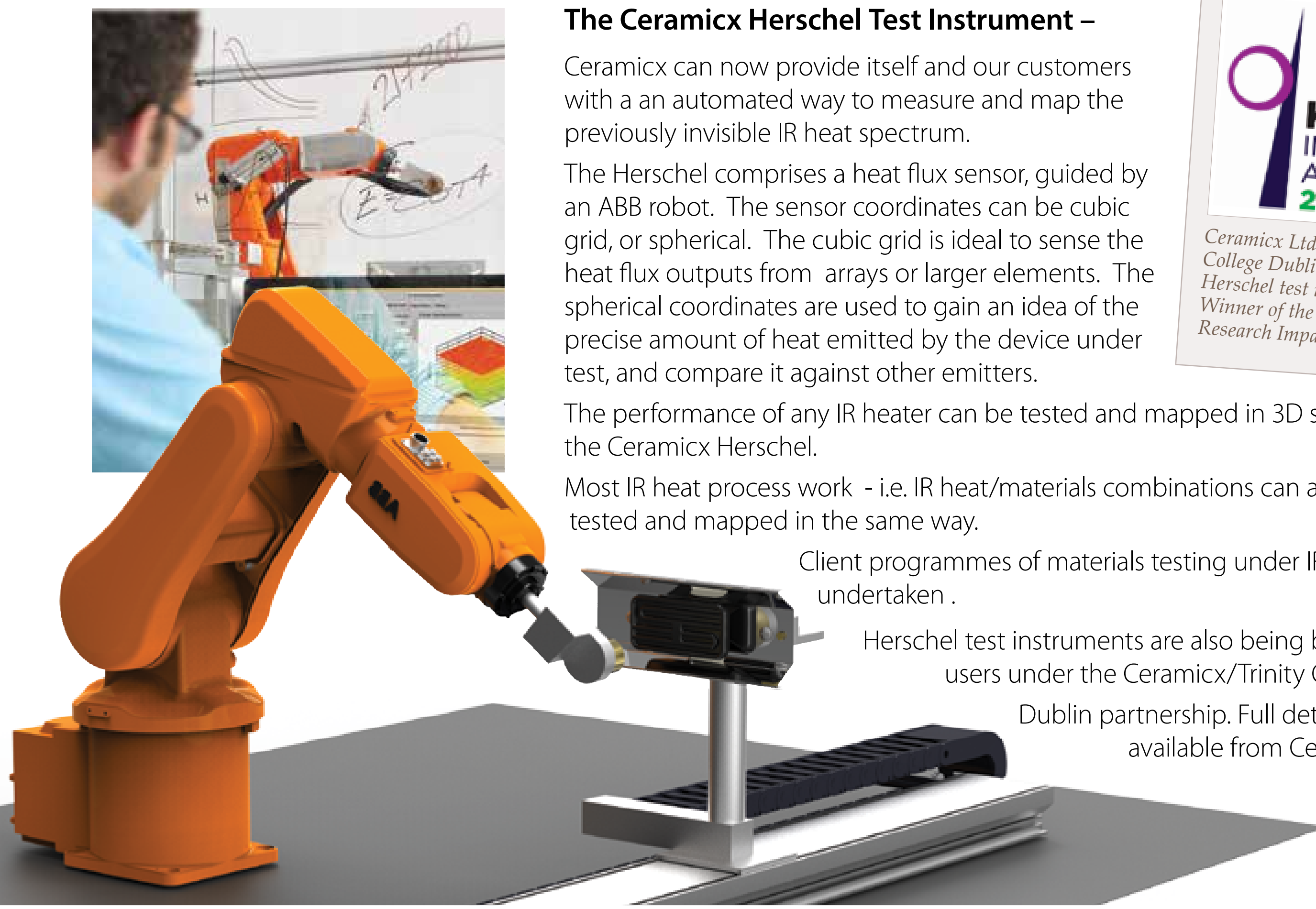
Fibre glass braided sleeving

Fibre glass braided sleeving non-impregnated
continued working temperature -60ºC to + 450ºC
Nominal diameter
2mm, 4mm, 6mm

* Sold in units of 10

Research and Development

The Research and Development guide can be viewed on line, downloaded from www.ceramicx.com/catalogues1/ or if you would prefer a hard copy, email a request with your details to david.hayward@ceramicx.com.

CERAMICX RESEARCH AND DEVELOPMENT RESOURCES



The Ceramicx Herschel Test Instrument –

Ceramicx can now provide itself and our customers with a an automated way to measure and map the previously invisible IR heat spectrum.

The Herschel comprises a heat flux sensor, guided by an ABB robot. The sensor coordinates can be cubic grid, or spherical. The cubic grid is ideal to sense the heat flux outputs from arrays or larger elements. The spherical coordinates are used to gain an idea of the precise amount of heat emitted by the device under test, and compare it against other emitters.

Ceramicx Ltd and Trinity College Dublin - The Herschel test instrument. Winner of the Collaborative Research Impact Award

The performance of any IR heater can be tested and mapped in 3D space by the Ceramicx Herschel.

Most IR heat process work - i.e. IR heat/materials combinations can also be tested and mapped in the same way.

Client programmes of materials testing under IR heat are undertaken .

Herschel test instruments are also being built for users under the Ceramicx/Trinity College Dublin partnership. Full details from available from Ceramicx.

RESEARCH AND DEVELOPMENT OVENS

Left, 1.5kW bench top material test unit. Centre, 8kW bench top test unit supplied with 3 interchangeable infrared heating platens consisting of Ceramic, Quartz and Quartz Tungsten/Halogen Tubes.

The three pieces of lab test equipment shown are tools for determining the best emitter for a given material or job. All are available from Ceramicx, where the first two should be found in the arsenal of any serious user of infrared heat. The unit on the right was designed and manufactured to suit a customers specific requirement.

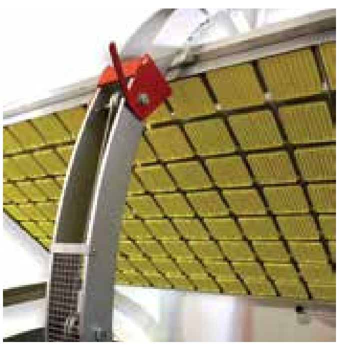
Infrared Solutions

The Ceramicx Industrial ovens and infrared solutions guide can be viewed on line ,downloaded from www.ceramicx.com/catalogues1/ or if you would prefer a hard copy, email a request with your details to david.hayward@ceramicx.com.

CONVEYOR OVENS



IN LINE THERMOFORMING OVENS




CUT SHEET THERMOFORMING OVENS

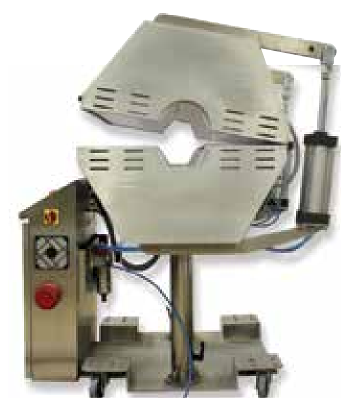


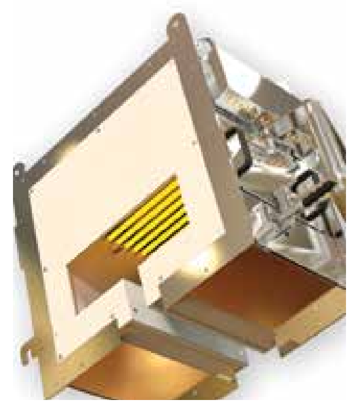
COMPOSITE THERMOFORMING OVENS


DRYING LINES AND CURING

PROCESS WELDING AND ADHESIVES

FURNACE OVENS

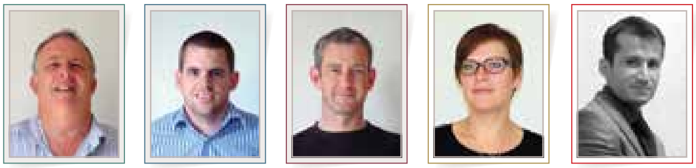




STEATITE AND ALUMINA DUST PRESSING

Talk to us today about your infrared heating needs.

ceramicx
INFRARED FOR INDUSTRY



- Frank Wilson — *Managing Director* — frank.wilson@ceramicx.com
- Dr. Cáthál Wilson — *Director* — cathal.wilson@ceramicx.co.uk
- Tadhg Whooley — *Technical Sales Manager* — tadhg.whooley@ceramicx.com
- Renata Cogan — *Sales and Logistics* — renata.cogan@ceramicx.com
- Hasan Duman — *Sales - Turkey* — hasan.duman@ceramicx.com

---

friedr. freek

www.freek.de

Distributor: **Friedr. Freek GmbH**
Address: Sudetenstraße 9, 58708 Menden, Germany
Tel: +49 23 73 - 95 90-0
Fax: +49 2373 9590-30
Email: mail@freek.de

- Stefan Düllmann
  Technical Sales
  s.duellmann@freek.de
- Mareike Blaak
  Sales and Marketing
  m.blaak@freek.de

---

gsae

www.ceramicx.com.cn

Distributor: **GSAE**
Address: Room 108, 1st floor Building No.1, 20 Bei Dong Lu, Tianhe District, Guangzhou City, 510665, China.
Tel: 020 82310060/020 82329785
Fax: 020 82000073
Email: sales@ceramicx.com.cn

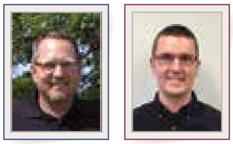
- Pingqiang Li
  Managing Director
  ceramicx@126.com
- Xu Shan
  International Business Engineer
  weiwei0604@yahoo.com

---

weco international inc

www.wecointernational.com

Distributor: **Weco International, Inc.**
Address: 841 Tacoma Ct. Clio, MI 48420
Tel: 810 - 686 - 7221, Toll Free:1-855-IR-2-HEAT
Fax: 810 - 686 - 7564
Email: weco@wecointernational.com



- Brett Wehner
  President/CEO
  brettw@wecointernational.com
- Brett Terbrack
  Technical Sales
  brett.terbrack@wecointernational.com

CHECKOUT ▶ ceramicx online**shop**

Infrared heating elements direct from the manufacturer

shoponline
UK **www.ceramicx.co.uk**
IRL **www.ceramicx.com**

For all non standard items contact sales@ceramicx.com

Ceramicx Ltd. Gortnagrough, Ballydehob, Co. Cork, P81 HO26, Ireland.
Tel: +353 28 37510 Fax: +353 28 37509 Email: sales@ceramicx.com **www.ceramicx.com**

Ceramicx Ltd. 20 Station Road, Cambridge, CB1 2DJ, U.K.
Tel: +44 1223 653159 Email: sales@ceramicx.co.uk **www.ceramicx.co.uk**

Ceramicx Ltd. Ceramicx İnfrared Teknolojileri Sanayi ve Tic. Ltd. Şti. İkitelli O.S.B. Giyim Sanatkarlari İş ve Tic. Mrkz.3. Ada A Blok No:102, Başakşehir, Istanbul / Türkiye.
Tel: +90 212 549 4839 Mobile:+90 544 237 2649 satis@ceramicx.com **www.ceramicx.com.tr**

日本ヒーター株式会社
NIPPON HEATER CO., LTD.
www.nippon-heater.co.jp

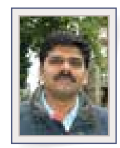
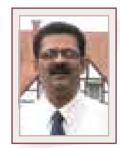
Distributor: **Nippon Heater Co.,Ltd.**
Address: 2-13-15, Keihinjima, Ota-ku, Tokyo, Japan.
Tel: +81 3 3790 3111
Fax: +81 3 3790 1711
Email: sales@nippon-heater.co.jp


- Koshiba Tomonobu
  President
  t-koshiba@nippon-heater.co.jp
- Hashimoto Atsushi
  Sales
  a-hashimoto@nippon-heater.co.jp

---

elmec
Heaters & Automation
www.elmec.in

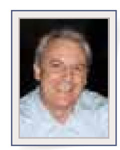
Distributor: **Elmec Heaters and Appliances**
Address: #103, SIDCO Industrial Estate, Ekkattuthangal, Chennai - 600032, India.
Tel: 0091 - 44 - 22250313 / 22253566
Mobile: 0091 928 222 7071
Email: info@elmec.in

- Mr. Sundarraj
  elmec.sundar@gmail.com
- Mr. Selvaraj

Abso Industries cc

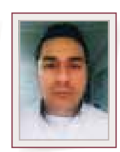
Distributor: **Abso Industries cc**
Address: Unit 9, The Square, Prime Park, Printers Way, Montague Gardens, 7447 Cape Town, South Africa.
Tel: +27 21 552 7303
Fax: +27 21 552 7304




- Bobby Bell
  Managing Director
  bobby@absoheating.co.za
- Marc Johnson
  Operations Manager

BACKER ALPE, S. DE R.L. DE C.V.
LEÓN | GUADALAJARA | MÉRIDA
MONTERREY | CIUDAD DE MÉXICO
www.backer-alpe.com

Distributor: **Backer Alpe**
Address: Blvd Lopez Mateos 306-Ote Colonia Centro, León, Guanajuato, CP 37000, Mexico.
Tel: 01-477-7145812
01-477-7162064

- Hector Mireles
  Director
  hector.mireles@backeralpe.com
- Alberto Montiel
  Trading Manager
  Alberto.montiel@backeralpe.com

---

www.**ceramicx**.com | www.ceramicx.co.uk

Siemens Financial Services now available

CERAMICX AS AN INFRARED OVEN OEM SUPPLIER IS PLEASED TO ANNOUNCE THAT IT IS NOW AN APPROVED COMPANY OF SIEMENS FINANCIAL SERVICES (SFS). SFS IS HAPPY TO SPEAK WITH ANY CUSTOMERS OR POTENTIAL CUSTOMERS OF CERAMICX WITH RESPECT TO FINANCING THEIR CAPITAL NEEDS.

With over 40 years' experience of providing finance to businesses, Siemens Financial Services (SFS) has been helping finance the future of manufacturing with its innovative and competitive financial solutions.

Initially focused around office technology and healthcare equipment SFS has more recently aligned itself closely with the engineering and manufacturing heritage of the broader Siemens. SFS is now placing a focus on delivering credit to customers of machine tooling and plastics industry manufacturing equipment - (whether OEMs or resellers).

SFS offers a selection of tailored asset finance options for manufacturing businesses* - including Hire Purchase, Finance Lease and Operating Lease.

So if you are an established business with a strong business plan purchasing an infrared solution from Ceramicx, there is a financing solution for you.

**Finance for businesses and other non-consumer opportunities only, subject to credit approval. This is not an offer to provide finance or any other terms. Quotations are subject to changes in funding costs, tax assumptions and credit policy. Any offer to provide finance will be subject to credit approval by Siemens Financial Services Limited and subject to terms and conditions. Provision of finance is subject to Service, Administration, Facility and Annual Services Fees*

Product Guide

INDUSTRIAL OVENS AND Infrared Solutions

The Ceramicx Guides.

Our 'Product Guide' outlines the complete range of Ceramicx infrared heating products. The guides companion 'Industrial Ovens and Infrared Solutions' looks at the application of these products in key industrial processes and market places and opportunities for infrared.

The Guides are intended for buyers and users of our infrared heating components and equipment.

The Guides will also be useful to stockists, distributors and agents around the world and to general readers who wish to gain an understanding of the world of infrared heating.

ONLINE INFRARED TR@INING COURSE

The course is divided into four modules that set out the basics of Infrared from an Industry perspective.

Each module will take 60-90 minutes to complete and finishes with a short online test. The modules can be taken online, or taught as part of a classroom course.

Module 1
Fundamentals of Heat Transfer and Infrared

Module 2
Infrared Energy in Process Heat

Module 3
Matching the Infrared Element to the Application

Module 4
Control of Infrared

The course is now available online at

www.ceramicx.com/applications-training/