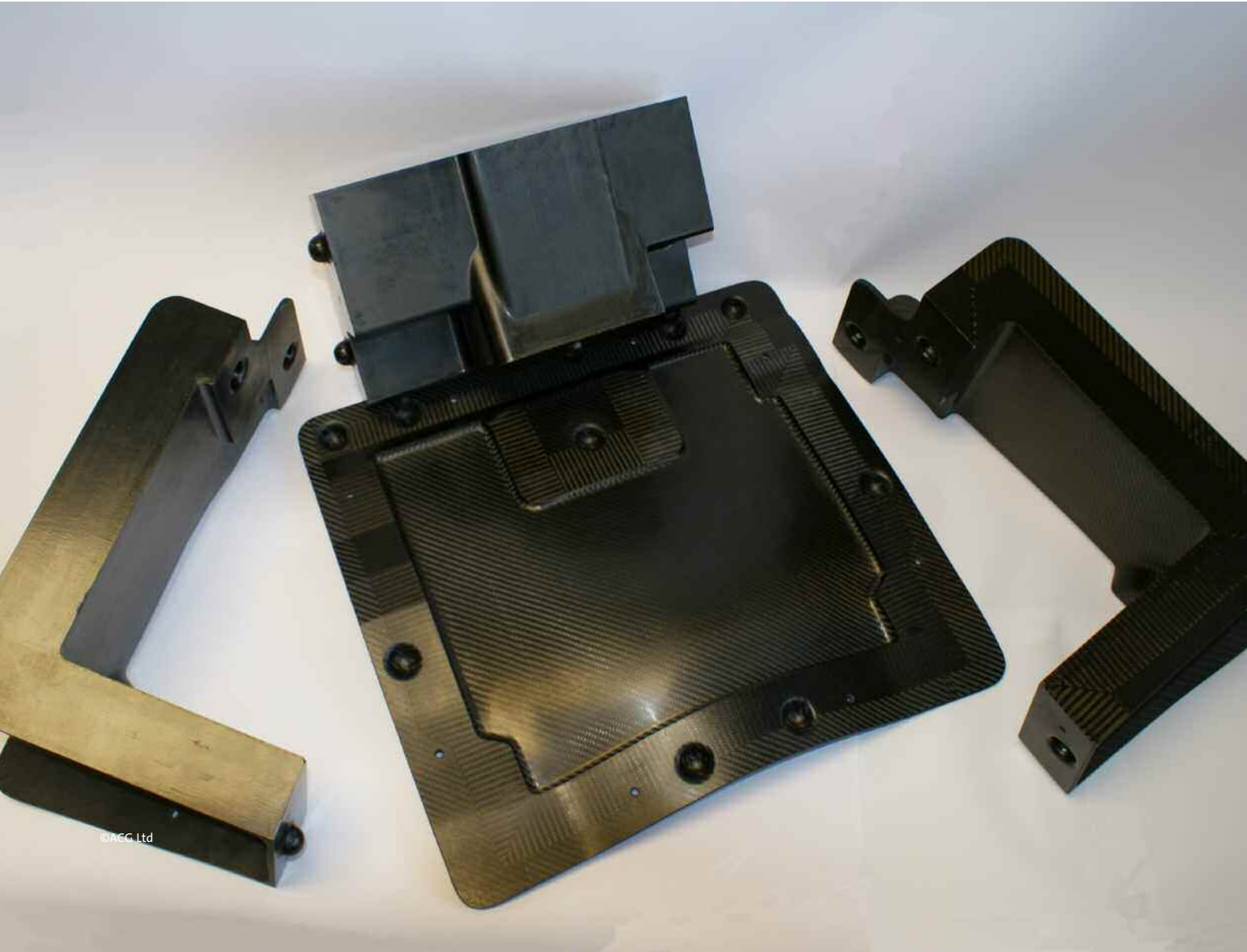




Advanced
Composites Group

umeco composites



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Technical Report and Case Study - DForm® Tooling

DForm Deformable Composite System (DCS) Technology

Short chopped fibres are often used in the composites world to remove 'architecture' and associated print-through from the structure, and to create a readily formable material. These are usually presented in the form of random mats which, although being readily deformed, offer poor translation of fibre properties and can only be considered, at best, to be semi-structural materials.

To achieve high performance from a readily formable composite without the print-through issues, fibre directionality and packing (fibre volume fraction) must be maintained.

ACG's DForm® Deformable Composite System (DCS) is an advanced, labour-saving prepreg technology that combines the conformability of a short fibre moulding compound with the directional characteristics of a high performance, long fibre composite.

This unique combination of characteristics is achieved through selective fibre slitting of a unidirectional prepreg precursor. This is presented in a multi-layer format that will flow under press or autoclave pressure, and readily conform to complex shapes.

How does it Work?

A woven, fabric-based composite, particularly one based on a twill or satin weave style, will readily deform around a complex shape. However, because conventional unidirectional prepreps are made-up of continuous fibres, they cannot stretch, and have a tendency to tear and, ultimately, split perpendicular to the fibre direction.

Cross-plying the unidirectional material will help overcome the splitting problem simply because the plies can support each other. However, the continuous fibres prevent any stretching of the material and, ultimately, lead to the formation of wrinkles.

If this exercise is repeated with the unidirectional (UD) fibres selectively slit, the plies can 'flow' and conform to the requisite shape as the slits open. Each slit only opens by a relatively small amount, but the sum of each of these movements allows the multi-ply material to deform around complex shapes.

The degree of conformability can be further modified by changing the cut density within each UD layer, thus changing the fibre length between cuts.

This format has created a short fibre composite material retaining the fibre alignment and packing properties of a high performance material, but with drape and handling characteristics approaching those of a woven fabric prepreg. However, it achieves this without the issue of the 'architecture' creating print-through.

Mechanical Properties of DForm

The mechanical performance of DForm is dictated not only by directionality and fibre volume fraction but also by fibre length. The DForm format addresses a number of processing and surface quality issues, but the reduction in fibre length will influence material properties.

Slitting of the fibre inter-layers had minimal effect on the tensile modulus of the laminates, but, as might be expected, the tensile strength showed a drop-off. However, when compared to the properties of a woven fabric laminate, this drop-off in strength is less pronounced.

Comparisons of compressive and inter-laminar performance show a similar pattern, but the relative differences are less significant.

DForm for Tooling:

Compared to standard fabric-based tooling systems, DForm offers considerable savings in lay-up times (typically 20 to 30%) through operational de-skilling as well as a superior surface

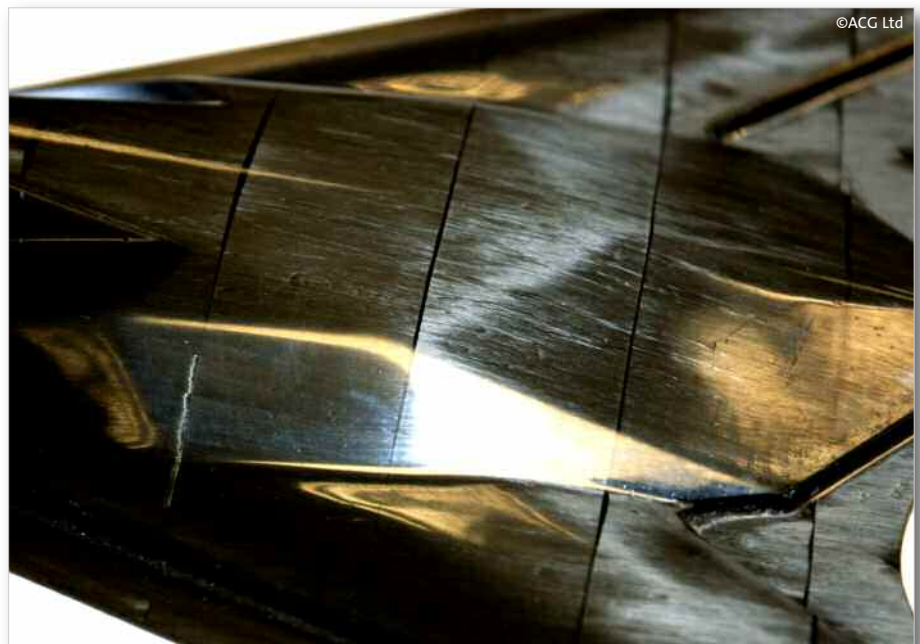
finish. Furthermore, the directional nature of DForm's structure helps to maintain dimensional accuracy and performance predictability, thereby presenting a major advantage over random short fibre and resin infusion tooling systems.

DForm will create an extremely flat, print-through free surface profile with no local thinning or loss of fibre orientation.

If a tool face is prone to surface damage, a standard surface ply can be used. Note that woven fabric strips can be laminated around the periphery to stop break-out of the unidirectional fibre.

Dr. John Nixon, ACG's Technical Marketing Manager, said: "This new, market leading technology is an exciting addition to our extensive product range.

DForm will allow customers to save money and improve efficiency whilst maintaining the high standard expected of our products. We look forward to working with customers to find and develop new and exciting applications for such a versatile technology."



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Lola Composites' Application Provides Endorsement

Cambridgeshire - U K based Lola Composites Ltd, a globally recognised supplier of advanced composites to the motorsport, aerospace, defence, communications, automotive and marine sectors, has made extensive use of ACG's innovative DForm®.

Lola Composites has used ACG's DForm DCS for tools in a number of programs over the last twelve months. As Rob Hewison, Lola's Technical Manager, said: "It has performed exactly as ACG predicted, giving us improved surface finish and a reduction in laminating time over the more traditional woven systems." He continues: "We are often very sceptical of claims regarding improvements in quality with the ability to manufacture tooling more quickly but, in both respects, DForm has delivered!"

Importantly for Lola, the new system was quickly adopted and implemented by the tooling shop with no problems being discovered, which is unusual as this is often the stumbling block in a department where you, more often than not, only get one chance to get the job right. The surface finish from a unidirectional based reinforcement is significantly better than that from a heavier woven reinforcement, although Lola still uses a lightweight woven first ply, the system can be used with the unidirectional material on the surface.

Rob Hewison states: "We keep the first ply as woven to guarantee durability, but we have tools in production with a unidirectional face that has been proven to be perfectly durable, producing hundreds of phenolic aerospace interior parts with no apparent degradation. He continues: "In particular, we are looking



at the system as a step forward in the drive for 'A Class' automotive composite tools as the tool has a significantly flatter finish than a traditionally manufactured prepreg tool." Rob Hewison concludes: "We like the system, and even on our complex race-car tooling, we find it to be easier to lay up than the more traditional all woven systems."

Where customers prefer Lola continues to use the entire suite of ACG tooling materials. However Lola is promoting DForm as a viable alternative that will allow the clients to reap the additional benefits of the system. Lola is keen to look at future developments in ACG's DForm system for the production of components.



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DForm tooling mould of the LMP1 engine cover.



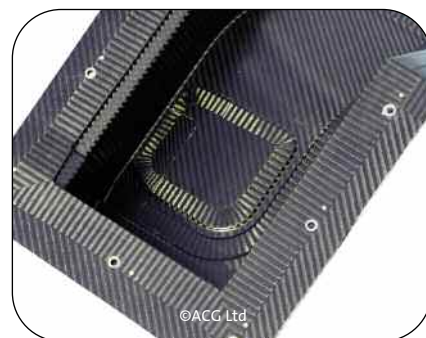
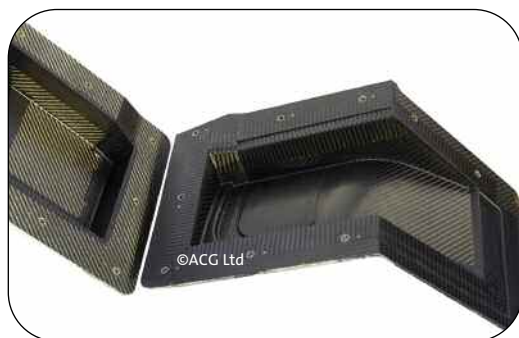
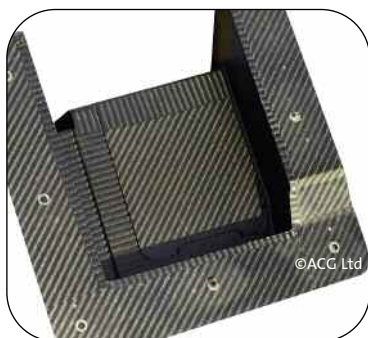
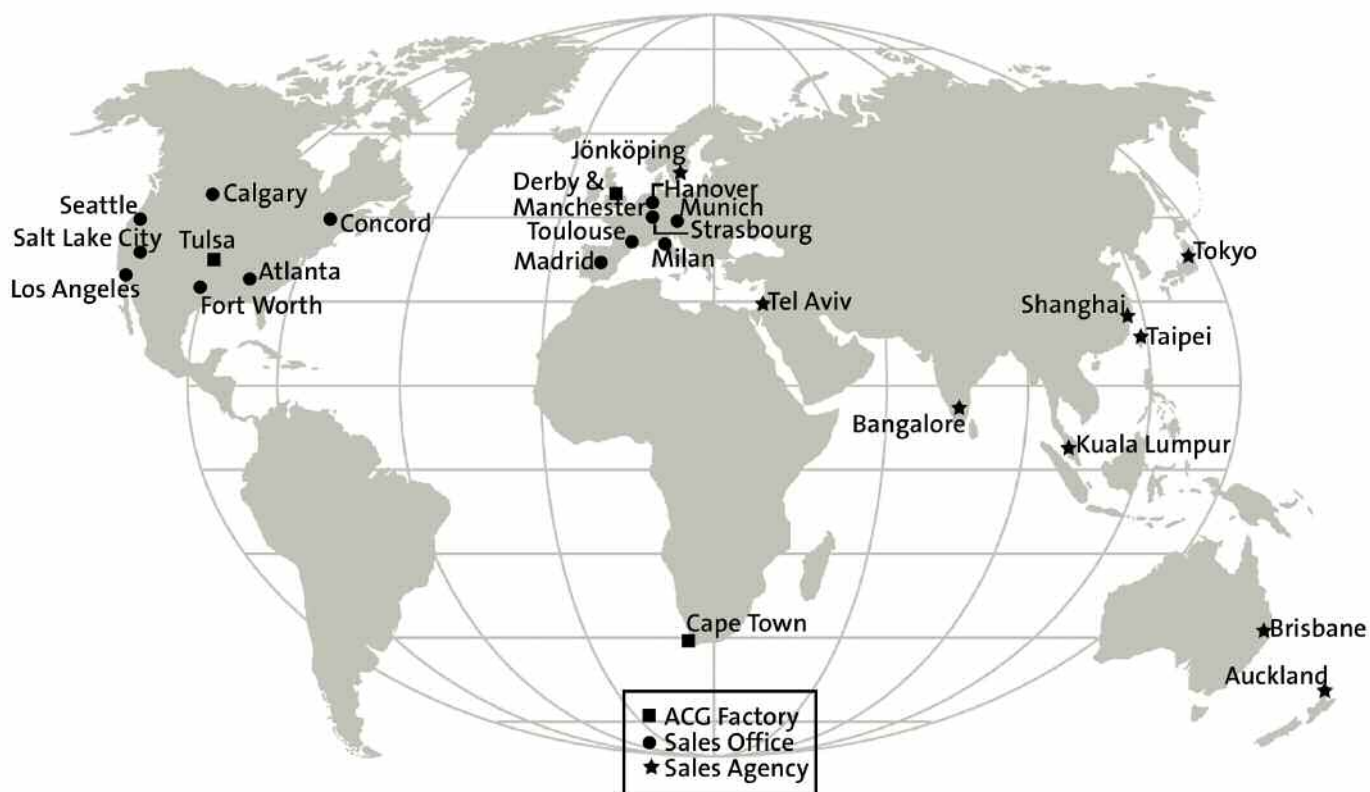
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