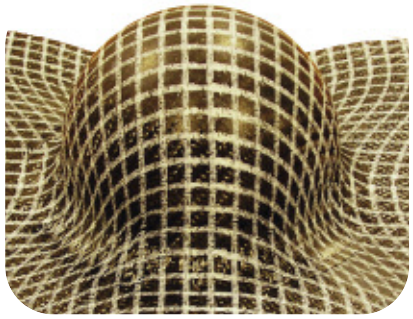
Advanced Composites Group
umeco composites

Technical Report - ACG DForm - Components



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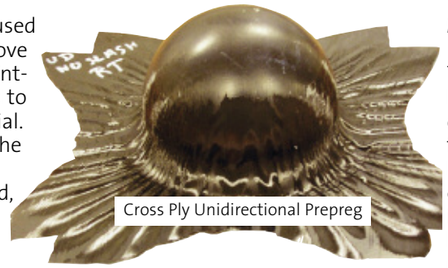
The Centre of Composites Technology

DForm DEFORMABLE COMPOSITE SYSTEM (DCS) TECHNOLOGY - COMPONENT MANUFACTURING POSSIBILITIES

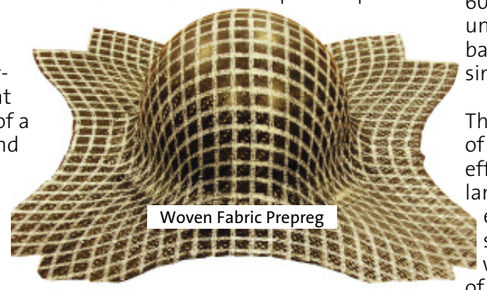
Short chopped fibres are often used in the composites world to remove 'architecture' and associated print-through from the structure, and to create a readily formable material. These are usually presented in the form of random mats which, although being readily deformed, offer poor translation of fibre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



Cross Ply Unidirectional Prepreg

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), for which patents have been lodged, 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.

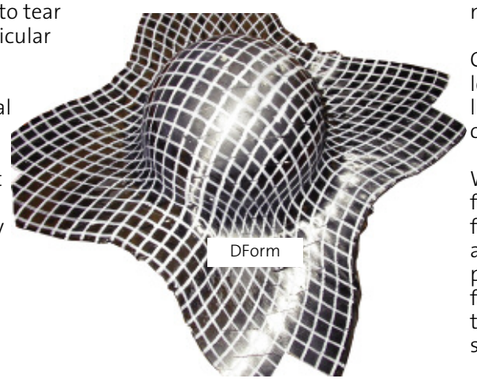

Woven Fabric Prepreg

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 prepregs 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.


DForm

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.

A programme of testing has been carried out to evaluate this. A series of samples were made using a standard unidirectional carbon prepreg.

DForm formats were made with effective fibre lengths of 20, 40 and 60mm and compared with cross-ply unidirectional and woven fabric-based prepregs processed under similar conditions.

The results showed that the 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 did not appear to be severe. Graphs can be made available to support these findings.

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

DForm Component Application

The results of the mechanical testing demonstrated that, as might be expected, there is some drop-off in mechanical performance due to the fibre slitting process. However, the laminate stiffness showed minimal variation in fibre length.

Clearly, this is a technology that lends itself to the production of lightweight, high stiffness components.

While still undergoing development for components, the potential exists for DForm technology to offer many advantages in automotive body panel applications. Here, a woven fabric reinforcement can 'print-through' and detract from the final surface finish.

Despite the ability to address print-through by applying some fairly extreme measures when finishing and painting, there is still the potential for this condition to appear in the long-term.

It is well known that a unidirectional material on the surface can help eliminate this problem as there is no fabric structure. However, forming a uni-directional prepreg around the complex curvatures of automotive body panels has proved to be quite difficult.

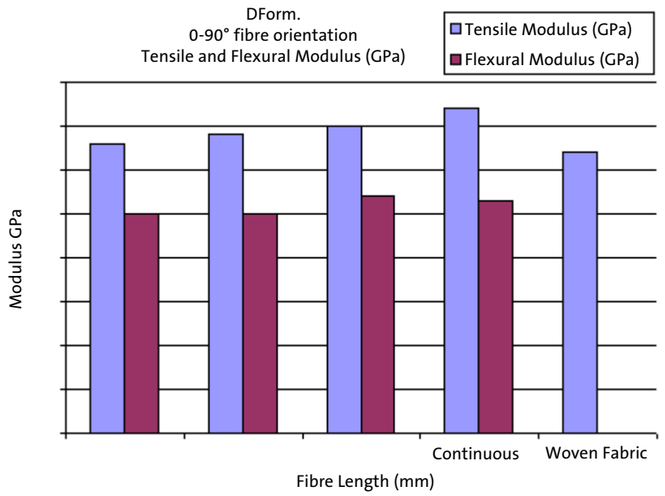
The deformation characteristics of ACG's DForm format can address these issues and allow complex shapes to be readily moulded.

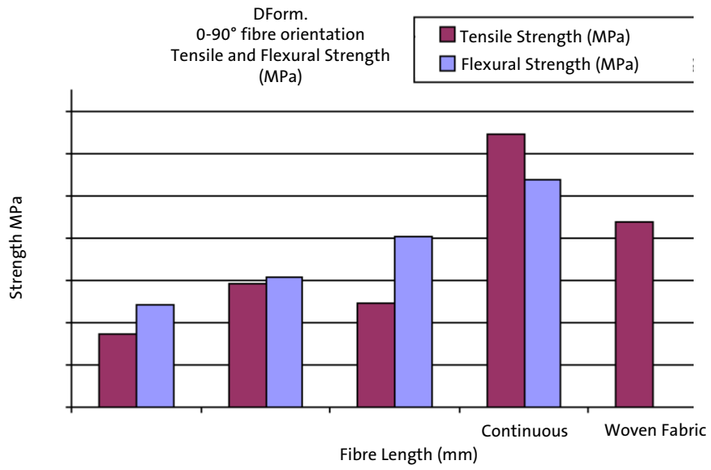
DForm will readily flow under pressure and, therefore, is an ideal material for press moulding. The material will flow and deform around complex geometries and sharp corners, thus offering a significant advantage over conventional woven materials.

The component shown was manufactured from a flat six-ply DForm pack in a heated aluminium press tool.

No preforming of the stack was carried out before placing the material in the tool. It shows how the fibre web has flowed and formed around details and corners.

This material format has many potential applications in semi-automated processes such as diaphragm forming and the press moulding of complex geometry components.





DForm Body Panel

Press Moulded DForm Mould Component

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