INVESTIGATION OF PREFORM MANUFACTURING TECHNIQUES
USING NOVEL BINDER COATED CARBON FIBRE TOWS

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INTRODUCTION

In the aerospace industry, Resin Transfer Moulding (RTM) and vacuum infusion processing are replacing pre-preg autoclaving moulding to reduce manufacturing costs. These processes require the assembly of a reinforced preform. Fabrics are cut and draped and after sprinkling or spraying epoxy powder binder, they become compacted and adhered.

The EU PreCarBi project is investigating the use of preform assembly using binder coated carbon fibre tows which are being developed as part of the project. The preform is either laminated using a tow placement system (Fig. 1) or made from fabrics assembled with binder coated tows.

This is possible as binder tows are not tacky at room temperature and can be used in conventional textile machinery for production of fabrics (e.g. Weaves, NCF, etc) in conjunction with normal carbon fibres or entirely on their own (Fig. 2). The fabrics can then be draped or formed to a near net shape of the final geometry, then heated to achieve inter-yarn adhesion and finally cooled down to room temperature when the preform becomes robust (rigid) and may be handled and transported to another facility where it will be infused with resin. This process is referred to as Activation.

This paper investigates the effects of some of the processing parameters on preform robustness.

Fig. 1: Production of binder yarn preforms using filament winding [1].

Fig. 2: Production of hybrid binder yarn textiles [1].

PREFORM ASSEMBLY TECHNIQUES

The heating systems considered in this paper for activating binder coated tows are Electric ventilated and infrared ovens, CO₂ Laser, Nd:YAG Laser, Air Gun, Ultrasonic Gun and heated rollers. Manufacturing trials are carried out with the aim of identifying potential advantages and
disadvantages with regards to system parameters. Environmental scanning electron microscopy (ESEM) is used to detect presence of thermal damage to the binder tow within an activation temperature envelope. Using a modified version of the Double Cantilever Beam (DCB) test, mode I interlaminar fracture toughness $G_{IC}$, of the specimens is determined. A simple tow pull-out test is used to study the adhesion strength of the binder. These characterisation techniques are also applied to investigate the effects of repeated re-activation of the binder.

**ACTIVATION TECHNIQUE CHARACTERISATION**

Each activation system is best suited to a particular processing technique such as Automated Fibre Placement or Textiles. Due to their relatively homogenous but imprecise application of heat to the preform (i.e. heat is applied to a general area), electric and infrared ovens could be used in textile processes. In an AFP set-up however, the precision with which energy is applied to a prescribed co-ordinate on the preform is of higher importance.

ESEM micrographs (Fig. 3) are used to investigate the amount of binder damage which may occur at certain areas within the activation temperature envelope. The regions with thermal damage have a lower apparent binder density. Mode I $G_{IC}$ values obtained from DCB tests (Fig. 4) and adhesion strength values obtained from tow pull-out test carried out on specimen manufactured with the candidate activation systems are compared and presented.

The same methodology is applied to investigate the consequences of repeated activation of each specimen.

![Fig. 3: ESEM micrograph showing binder particles.](image1)

![Fig. 4: A DCB test in progress](image2)

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**REFERENCES**

1- PreCarBi Proposal No. 30848; April 2006.