FRACTURE TOUGHNESS OF MULTI SCALE COMPOSITES: MANUFACTURING METHODS

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Although composites have a number of superior properties to most metals, their through-thickness properties and delamination resistance are poor. These limitations could be alleviated by the addition of nanoscale reinforcements such as surface treated carbon nanotubes and graphene nanoplatelets. This project looks at the manufacturing techniques of multiscale composites such as these for Mode I fracture toughness testing.

Nanomaterials Used

Initial tapered double cantilever beam tests showed that untreated nanotubes do not disperse well (see figure 2) so were discarded for the DCB tests. Instead the following materials were used:

- O_2 treated GNPs
- O_2 treated Bayer tube CNTs
- O_2 treated Nanocyl CNTs
- Acid treated Bayer tube CNTs

Carbon fibre DCBs

Glass fibre DCBs

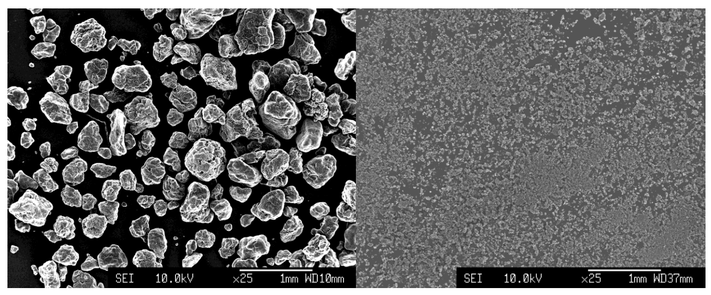

Figure 1: SEM photos L-R As received Bayer tubes, O_2 treated Bayer tubes

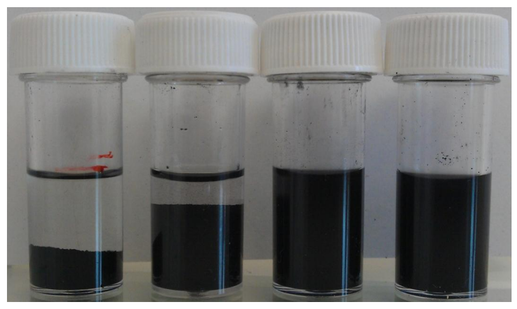

Figure 2: CNTs dispersed in ethanol L-R As received Bayer tubes, Acid treated Bayer tubes, O_2 treated Bayer tubes, O_2 treated Nanocyl

Double Cantilever Beams

Manufacture Process

The CNTs were dispersed in ethanol and pipetted at the top of a composite ply.

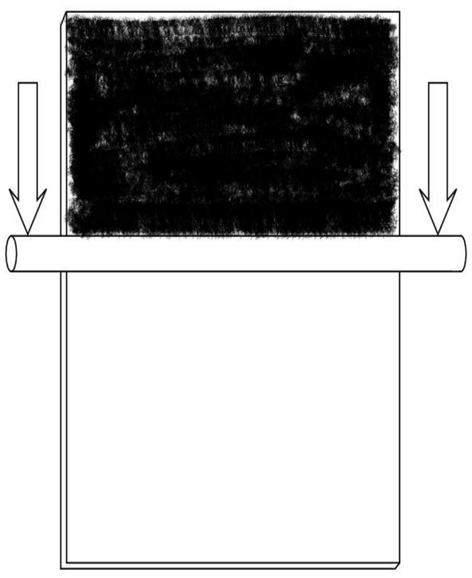

Figure 3: Drawdown coating procedure

Figure 4: Coated ply

Testing

The DCB tests were carried out using the Mode I experimental set up as shown in figure 5.

Figure 5: Testing DCB

Results

- As seen in figure 2 the dispersion quality varied between treatments: best being with O_2 treated CNTs and worst with untreated CNTs.
- Nanocyl CNTs were more viscous and required more ethanol for dispersion.
- The drawdown method resulted in some agglomeration and could often produce plies like that shown in figure 6.
- Some of the reinforced DCBs showed significant improvements when tested, particularly when using glass fibres as seen in figure 7.

Figure 6: Inconsistent coated ply example

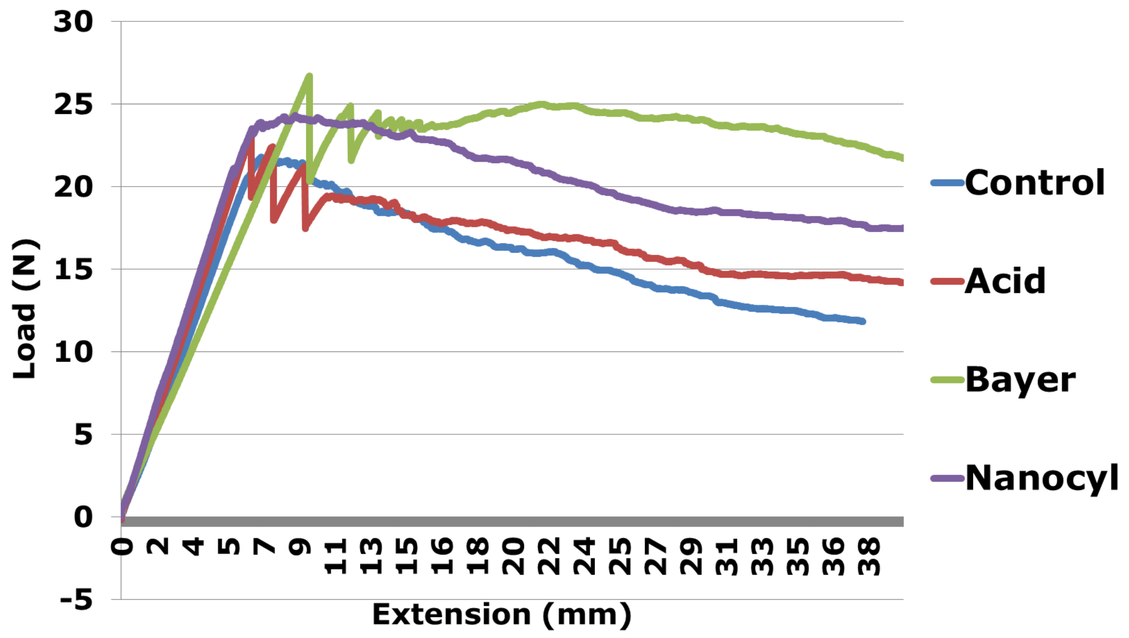

Figure 7: Glass Fibre DCB Results