VISUALISATION OF SELF-HEALING MECHANISMS IN FIBRE REINFORCED POLYMERS

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ABSTRACT

Despite their excellent in plane properties, conventional laminated fibre reinforced polymers are restricted in their potential by their through thickness matrix dominated properties. The brittle nature of the traditional epoxy matrix means that impact on the laminate can result in substantial internal damage which is difficult to detect visually and reduces the structural load carrying capability. The damage manifests as matrix cracks between parallel fibres and delamination at the interfaces of plies with dissimilar fibre orientation - Figure 1. Under loading, and in particular compression, this damage can propagate, further weakening the structure before leading to catastrophic failure. The current approach to composite design mandates low strain levels to inhibit damage growth and, therefore, failure, but this leads to oversize, inefficient structures [1]. One alternative approach is to utilise the hierarchical architecture of FRPs and insert a self-healing functionality such that damage may be repaired in-situ.

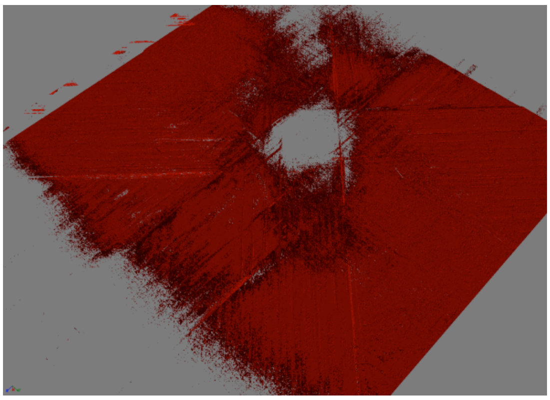

Figure 1: 3D micro CT scan reconstruction of damage created in a quasi-isotropic CFRP laminate by a low velocity (4J) impact

Over the last decade, researchers have successfully demonstrated that self-healing in FRPs is possible with the recovery of significant proportions of the undamaged mechanical properties. Hollow glass fibres carrying a healing agent have been embedded in FRP laminates which have been subsequently damaged and then healed [2-6] - **Figure 2**. However, until now little research has investigated the internal mechanism by which healing occurs. The work presented in this paper focuses on analysing the mechanisms and processes behind the healing of damage using CT scanning techniques to visualise the healing distribution system, healing agent and their interaction with the damage volume created by a low velocity impact event. Layers of hollow glass fibres were introduced at various

interfaces within carbon fibre epoxy laminates. The laminates were then cured before the HGF were infused with an epoxy based healing agent mixed with an X-ray contrast agent. The laminates were then subject to low velocity impacts and allowed to heal before microCT scanning was used to establish the distribution and location of the healing resin.

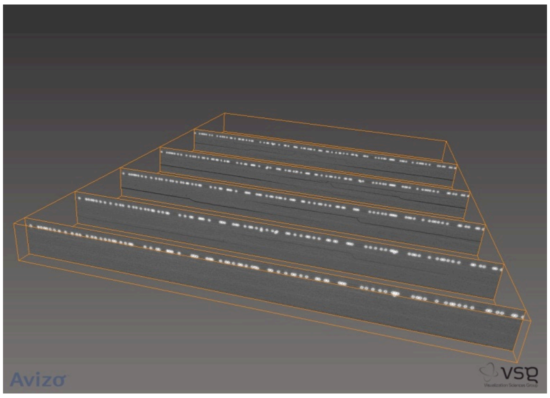

Figure 2: MicroCT slices through a CFRP laminate containing a single layer of HGF (white)

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