Two Dimensional Numerical Model to Predict the Thermo-Chemical Degradation to a Piece of Carbon Fibre Composite (CFC) Due to Laser Ablation

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There is a growing interest in using carbon fibre composites (CFC) as a high tech construction material. The reason for this is that CFCs have similar mechanical performance to that of the more traditionally used materials like aluminium alloys, whilst being considerable lighter. The benefits of using a lighter material are vast.

However whilst CFC have similar structural properties to that of aluminium its electrical and thermal properties are very different. This becomes important if CFCs are placed in an environment where the pieces of CFC could be struck by lightning as this interaction will damage the panels [1]. Previous studies published by N. Jennings and C. J. Hardwick [2] and F Lago et. al. [3] have attempted to model the damage caused to a piece of CFC due to a lightning strike. However these models have only considered very simple degradation methods and also did not include gas transport. The study presented here is an expansion of what has been discussed previously [4].

A two dimensional numerical model has been built which is designed to predict the damaged caused to a piece of CFC due to a lightning strike. Initial verification of the model is conducted by decoupling the thermal physics from the electrical effects and damaging the pieces of CFC by using laser ablation. The two dimensional numerical model (2D) includes thermal chemical degradation of the polymer via pyrolysis, the resultant gas transport through the decomposing material and carbon fibre vaporisation. An image of the x-ray tomography results of the laser ablated CFC samples are shown in figure 1.

The predictions from the 2D model provide a reasonable agreement with the experimental results. Although further expansion of the model, into three dimensions, is required before a true validation of the numerical predictions can be achieved.

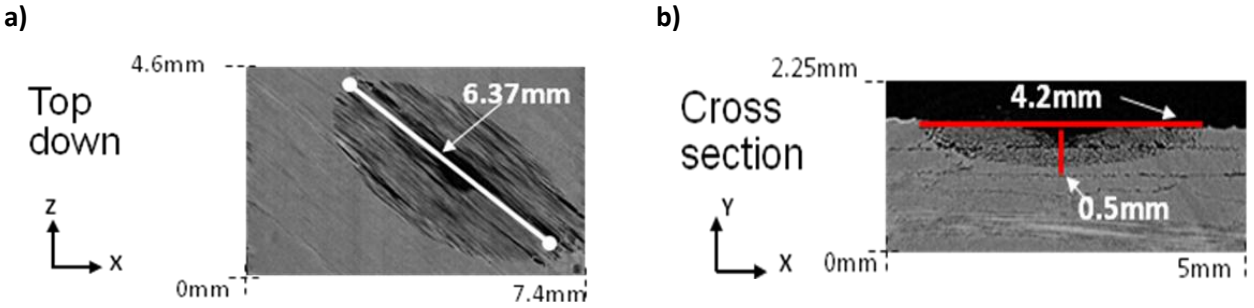

Figure 1. Images of the laser ablated CFC sample taken with X-ray tomography. The grey regions are undamaged material and black depicts were there is no material. a) Cross section view of damage. b) Top down view. The dark area in the centre shows were the carbon fibres have been evaporated away

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[2] Jennings N, Hardwick C J, "A computational approach to predicting the extent of arc root damage in CFC panels", ICOLSE, Atlantic City, 1992.
[3] Lago F, Gonzalez J J, Freton P and Gleizes A 2004 A numerical modelling of an electric arc and its interaction with an anode: part III. Application to the interaction of a lightning strike and an aircraft in flight *J. Phys.* D: Appl. Phys. 39 2297-02310
[4] Chippendale R D, Golosnoy I O, Lewin P L, Murugan G S and Lambert J. "Model of Structural Damage to Carbon Fibre Composites due to Thermo-Electric Effects of Lightning Strikes" ICLP 2010