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Influence of Thermal Damage on the Mechanical Strength of Trimmed CFRP

Authors : Guillaume Mullier, Jean François Chatelain

Abstract : Carbon Fiber Reinforced Plastics (CFRPs) are widely used for advanced applications, in particular in aerospace, automotive and wind energy industries. Once cured to near net shape, CFRP parts need several finishing operations such as trimming, milling or drilling in order to accommodate fastening hardware and meeting the final dimensions. The present research aims to study the effect of the cutting temperature in trimming on the mechanical strength of high performance CFRP laminates used for aeronautics applications. The cutting temperature is of great importance when dealing with trimming of CFRP. Temperatures higher than the glass-transition temperature (Tg) of the resin matrix are highly undesirable: they cause degradation of the matrix in the trimmed edges area, which can severely affect the mechanical performance of the entire component. In this study, a 9.50 mm diameter CVD diamond coated carbide tool with six flutes was used to trim 24-plies CFRP laminates. A 300 m/min cutting speed and 1140 mm/min feed rate were used in the experiments. The tool was heated prior to trimming using a blowtorch, for temperatures ranging from 20°C to 300°C. The temperature at the cutting edge was measured using embedded K-Type thermocouples. Samples trimmed for different cutting temperatures, below and above Tg, were mechanically tested using three-points bending short-beam loading configurations. New cutting tools as well as worn cutting tools were utilized for the experiments. The experiments with the new tools could not prove any correlation between the length of cut, the cutting temperature and the mechanical performance. Thus mechanical strength was constant, regardless of the cutting temperature. However, for worn tools, producing a cutting temperature rising up to 450°C, thermal damage of the resin was observed. The mechanical tests showed a reduced mean resistance in short beam configuration, while the resistance in three point bending decreases with increase of the cutting temperature.

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