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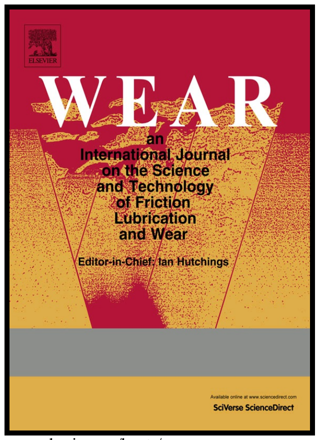

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Wear behaviour of CVD diamond-coated tools in the drilling of woven CFRP composites

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Abstract

The high specific strength/modulus of carbon fibre reinforced polymer composites (CFRPs) has led to their widespread use in the aerospace industry. Unfortunately, woven CFRP laminate can be exceedingly difficult to drill, resulting in rapid tool wear and fracturing. This work examines tools with novel geometric designs, such as double-point and multi-facet drills with diamond coatings. Experiments were conducted to characterize tool wear and fracture modes at two cutting speeds (50 and 75 m/min) and three feed rates (0.05, 0.1, 0.15 mm/rev) under dry conditions. This produced thrust forces of up to 128.28 N and torque values reaching 0.33 Nm, with a measuring temperature of ~135 °C. The double-point drill presented various tool wear patterns, including chipping and delamination of the diamond-coated layer. The tool wear patterns on the multi-facet drill included progressive abrasion wear, scoring and severe three body abrasion along the cutting lips on the first, second and the third facets respectively. The double-point drills presented fatigue ruptures, whereas the multi-facet drills showed chipping and micro-cracks under the chattering and excessive vibration during drilling. When the thermally induced static stress was imposed on the effects of the compressive residual stress, the observed Raman shift of the diamond structure can be the result.