130 Measurement and Analysis of Tool Wear When Drilling CFRP

J. McClelland[1a], A. Murphy[1] and Y. Jin[1]

[1] School of Mechanical and Aerospace Engineering, Queen's University Belfast, Northern Ireland.

[a] jmcclelland08@qub.ac.uk

Abstract.

Carbon fibre reinforced polymers (CFRP) are increasingly being used in aerospace structures due to high specific strength/stiffness and corrosion resistance. Drilling holes to facilitate mechanical fastening of aircraft assemblies is a critical manufacturing process and any errors at this late stage can be expensive in both time and resources. Compared to drilling conventional metals, numerous unique challenges are faced when drilling CFRP, due to the inhomogeneous and anisotropic (directionally dependant strength) nature of the material. Consequently, substantial efforts have been made to research hole generation techniques and the ability to establish high quality holes has been successfully achieved, albeit a very difficult task. Conversely, the phenomenon of tool wear, the mechanics involved and the resulting effect on the drilling process as a whole, has not been as thoroughly studied throughout literature.

Accordingly, this paper presents the findings from an experimental investigation into tool wear when drilling industrial grade unidirectional CFRP laminate with commercially available tooling. The variation of cutting and thrust forces alongside the change in drilling temperature were investigated with the use of a four component Kistler force dynamometer and FLIR thermal imaging camera, respectively. The evolution in cutting edge geometry was measured using a non-contact focus variation micro-scale Alicona Infinitefocus G5 microscope alongside a custom-built tool holding apparatus.

In conclusion, the effect of varying drilling speeds and feeds on the rate and magnitude of tool wear is presented while the differences in wear, drilling force and temperature when drilling with polycrystalline diamond (PCD) coated tools versus uncoated tungsten carbide (WC) tools are discussed. Explanations for the mechanics of the tool-workpiece contact are given at the micro level, based on the experimental data and relevant literature.