Accepted Manuscript

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PII: S0924-0136(18)30191-2
DOI: https://doi.org/10.1016/j.jmatprotec.2018.04.044
Reference: PROTEC 15744

To appear in: *Journal of Materials Processing Technology*

Received date: 22-2-2018
Revised date: 9-4-2018
Accepted date: 26-4-2018

Please cite this article as: Zhu Z, Guo K, Sun J, Li J, Liu Y, Zheng Y, Chen L, Evaluation of novel tool geometries in dry drilling aluminium 2024-T351/titanium Ti6Al4V stack, *Journal of Materials Processing Tech.* (2010), https://doi.org/10.1016/j.jmatprotec.2018.04.044

Evaluation of novel tool geometries in dry drilling aluminium 2024-T351/titanium Ti6Al4V stack

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Abstract:

Three novel drill geometries, multipoint, step and double cone, were designed and experimentally evaluated to understand the effect of tool geometries on the machining performance of dry drilling Al/Ti stack. Results showed that the double cone drill achieved a better hole quality and a higher efficiency due to the smaller thrust force, broken chips, and less burrs compared to the other two drill geometries. The multipoint drill generated serrated chips in titanium alloy drilling. Significant microstructure deformation occurred in the adiabatic shear band (ASB) and the second shear band. Visible cracks propagated along the ASB from the free to back surface of the chip. Phase transformation from β phase to martensite occurred in the second shear band. The drill geometry design and experimental investigation in this paper could provide guidance for drill bit design and manufacturing for Al/Ti stack drilling.

Keywords: Tool geometry; Machining characteristic; Drilling; Al/Ti stack

1. Introduction

Hybrid composite stacks are the materials made of multi-layers of aluminum and titanium alloys (Al/Ti), carbon fiber reinforced polymer (CFRP) and aluminum alloy (CFRP/Al), CFRP and titanium alloy (CFRP/Ti), or CFRP, aluminum and titanium alloys (CFRP/Al/Ti). The hybrid stacks have been extensively used in modern aerospace and aviation industries to fabricate load-bearing components for their high specific strength, fracture resistance, and general corrosion resistance (Xu et al., 2016). Machining of the hybrid stack is challenging due to the disparate properties of each stacked constituent and their respectively poor machinability.