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3-D Finite Element Process Simulation of Micro-end Milling Ti-6Al-4V Titanium Alloy: Experimental Validations on Chip Flow and Tool Wear

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Abstract

Finite Element (FE) simulation of machining can be used as a replacement or a supplementary to the physical experiment allowing an analysis to be performed at a lower cost. Besides, FE simulation can offer predictions of process variables which are difficult to obtain by experiment. This paper provides investigations on 3-D FE modeling and simulation of micro-end milling process for Ti-6Al-4V titanium alloy. 3-D FE models proposed for full-immersion, half immersion up and down milling are utilized to study the influence of increasing tool edge radius due to wear on the process performance of micro-end milling. Predicted 3-D chip flow and shapes are compared against the experiments which provided reasonably good agreements. Tool wear along the micro-end milling tool is predicted and validated with experiments. The results of this study indicated that tool wear has a significant impact to the cutting force, cutting temperature, tool wear rate, chip flow and burr formation. In addition, a comparison of 3-D and 2-D FE simulations is provided giving a better understanding of utilizing their predictions.

Keywords

Micro-milling; titanium; Finite element; chip flow; tool wear

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