A Mechanistic Model for Prediction of Cutting Parameters in Micro-Scale Milling

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While down-scaling of micro milling process is similar to the conventional process, there are specific issues that differ from macro machining due to higher ratios of feed per tooth to tool radius and tool run-out to tool diameter, size-effect, minimum chip thickness, elastic-plastic deformation, microstructure effects, etc. One of the challenges in micro machining is attaining accurate and reliable machining parameters, which can reduce tool wear and breakage to achieve higher productivity and quality at a lower cost. Therefore, this paper presents a new mechanistic model for predicting the precise process parameters considering material properties and principles of micro-milling under various cutting conditions. The proposed model also takes into account the nonlinearity and dynamics of minimum chip-thickness, micro-milling cutting forces considering cutting, as well as edge and damping coefficients into. The predicted stability lobes and the stability limits from experiments are in sufficient agreement. The research of micro-scale milling parameters is significant to improve the precision of machined parts, reduce the wear and tear of the micro-milling blade and extend the life of micro-tools.

Keywords: Micro chatter, Lobe diagram, Spindle speed, Axial cutting depth, Damping effect.

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