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Micro-Milling Process Development of Advanced Materials

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Abstract : Micro-level machining of metals is a developing field which has shown to be a prospective approach to produce features on the parts in the range of a few to a few hundred microns with acceptable machining quality. It is known that the mechanics (i.e. the material removal mechanism) of micro-machining and conventional machining have significant differences due to the scaling effects associated with tool-geometry, tool material and work piece material characteristics. Shape memory alloys (SMAs) are those metal alloys which display two exceptional properties, pseudoelasticity and the shape memory effect (SME). Nickel-titanium (NiTi) alloys are one of those unique metal alloys. NiTi alloys are known to be difficult-to-cut materials specifically by using conventional machining techniques due to their explicit properties. Their high ductility, high amount of strain hardening, and unusual stress–strain behaviour are the main properties accountable for their poor machinability in terms of tool wear and work piece quality. The motivation of this research work was to address the challenges and issues of micro-machining combining with those of machining of NiTi alloy which can affect the desired performance level of machining outputs. To explore the significance of range of cutting conditions on surface roughness and tool wear, machining tests were conducted on NiTi. Influence of different cutting conditions and cutting tools on surface and sub-surface deformation in work piece was investigated. Design of experiments strategy (L9 Array) was applied to determine the key process variables. The dominant cutting parameters were determined by analysis of variance. These findings showed that feed rate was the dominant factor on surface roughness whereas depth of cut found to be dominant factor as far as tool wear was concerned. The lowest surface roughness was achieved at the feed rate of equal to the cutting edge radius where as the lowest flank wear was observed at lowest depth of cut. Repeated machining trials have yet to be carried out in order to observe the tool life, sub-surface deformation and strain induced hardening which are also expecting to be amongst the critical issues in micro machining of NiTi. The machining performance using different cutting fluids and strategies have yet to be studied.

Keywords : nickel titanium, micro-machining, surface roughness, machinability
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