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Formability and Force Analysis of Steel Foils in Single Point Micro-Incremental Forming (SPMIF)

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Abstract

Single point incremental sheet forming (SPIF) is one of the latest near-net shape manufacturing technologies in which sheet metals are subjected to a step by step plastic local-deformation to form the final geometry. In this regard, many researchers have made an attempt to increase the flexibility and accuracy of the process by deforming the sheet at micro scales under the name 'Single Point Micro Incremental Forming (SPMIF)'. In this paper, it is attempted to investigate the forming limits and forming forces in micro-features formed by SPMIF on stainless steel foils of 0.04 mm thick. A 3-axis CNC vertical milling machine was used to deform the foils with the hemispherical end tool tip diameters of 200 µm and 300 µm. The effect of rotational speed on the forming forces and forming limits of stainless steel foils has also been reported. Taguchi's L_{18}orthogonal array was used to analyze the effect of spindle speed, tool tip diameter and incremental step-down. It was found that forming forces decreases with the increase in spindle speed and the process was feasible enough to produce pyramids in micro-scale with higher forming limits than conventional forming.

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Keywords: Single Point Micro Incremental forming (SPMIF); Micro-forming; Formability; Forming Forces.

1. Introduction to Micro factories

Micro factories have been developed to realize micro machines or micro-electro-mechanical systems (MEMS), and three-dimensional micro manufacturing. A micro factory can be defined as a small manufacturing system which uses down scaled processes aimed to get higher productivities by consuming minimum resources and energy[1,2].

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