Analysis of Machining Parameters Effects on Surface Integrity of Titanium

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Understanding the effects of machining processes and parameters on the surface integrity of materials is crucial to the manufacturing industry, as the ability to predict residual stress (RS) allows manufacturers to accurately choose cutting parameters that result in optimum RS. Parts with near-surface compressive RS and minimum near-surface tensile RS are more durable and therefore have longer lifespans, which can reduce costs and material waste. The goals of this study were to demonstrate the significant impact of using sharp vs. worn tools and to validate the combination of the hole-drilling method and Digital Image Correlation (DIC) as an efficient and accurate technique for studying RS. To study the RS caused by sharp vs. worn tools, Ti-6Al4V was cut with a custom in-situ machine. The hole-drilling method and DIC were utilized to create strain fields, and a Matlab code was used to determine optimal virtual strain gauge orientations. RS vs. sub-surface depth values were then calculated using the software H-Drill. It was observed that the use of sharp tools resulted in desired near-surface compressive RS, while the use of worn tools resulted in undesirable near-surface tensile RS. The use of worn tools also resulted in a maximum stress depth that was roughly greater than twice that of samples cut with sharp tools. Overall, the use of worn tools is shown to have detrimental effects on the surface integrity of machined parts, and the hole-drilling method combined with DIC analysis is an efficient and accurate method for studying RS thus far.

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