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Influence of heat treatment on the residual stress-related machining distortion of Ti-6Al-4V alloy monolithic parts

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Abstract

Machining distortion caused by residual stresses is one of the major challenges in the production of thin-walled monolithic parts. One reason for the distortion is the relaxation of the initial residual stresses within the raw part due to the material removal during the machining process. The initial residual stresses mainly depend on the manufacturing process of the raw part and the subsequent heat treatment. This paper presents the results from a set of experimental and computational studies of the influence of heat treatment on residual stress-related machining distortion of Ti-6Al-4V alloy monolithic parts. A thermo-mechanical simulation of the heat treatment process is developed for the prediction of the initial residual stresses. For experimental validation, the contour method is used to quantify the initial residual stresses. Finally, machining tests are conducted to measure the final part distortion for two different residual stress states.

Keywords: Machining distortion; Residual stress; Milling, Ti-6Al-4V alloy; Heat treatment; Thermo-mechanical simulation; Monolothic parts; Contour method