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Appropriate heat treatment and incremental forming route to produce age-hardened components of Al-2219 alloy with minimized form error and high formability

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Abstract

Al-2219 alloy belongs to the class of age-hardenable materials applied in many industrial applications. To impart strength in components, it is usually tempered to T6 condition through age-hardening process. However, during this process, the components experience distortion thus adversely affecting the form accuracy. The present work is aimed at devising an appropriate processing route to produce age-hardened components through Incremental Sheet Forming (ISF) with reasonable accuracy and formability. Three different processing routes namely P-ISF-ST-T6 (ISF followed by solution treatment which is followed by age-hardening), P-ST-ISF-T6 (solution treatment followed by ISF which is followed by age-hardening) and P-ST-T6-ISF (solution treatment followed by age-hardening which is followed by ISF) are applied to produce a pyramid shape. The tensile properties of the starting sheet blank are observed to have significant influence both on the form error and formability. Yield strength appears to control the error in the flat wall and corner of pyramid in a way that the error decreases with a decrease in strength. Low yield strength, however, contrarily promotes geometrical error in the bottom of pyramid. Corner in the pyramid geometry suffers from the maximum error. Regarding formability, it is found to be governed by the area reduction in tensile fracture. The least cumulative error with reasonably high formability is offered by the P-ST-ISF-T6 route. The processing route is found to influence the distribution of residual stresses as well. The nature/magnitude of stresses in the material is transformed when ISF is performed, which further experience transformation if exposed to heat treatment. The material processed through the P-ST-T6-ISF route endures the maximum residual stresses, the route that also induces the highest form error. This reveals that higher residual stresses could cause higher form error in ISF.

Keyword: ISF; Heat Treatment; Form Accuracy; Properties; Residual Stresses

1. Introduction

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