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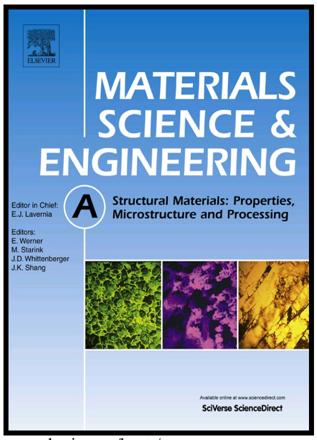

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Formability and microstructure evolution mechanisms of Ti6Al4V alloy during a novel hot stamping process

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Abstract

A novel hot stamping process for Ti6Al4V alloy using cold forming tools and a hot blank was presented in this paper. The formability of the material was studied through uniaxial tensile tests at temperatures ranging from 600 to 900 °C and strain rates ranging from 0.1 to 5 s^{-1}. An elongation ranging from 30% to 60% could be achieved at temperatures ranging from 750 to 900°C respectively. The main microstructure evolution mechanisms varied with the deformation temperature, including recovery, phase transformation and recrystallization. The hardness of the material after deformation first decreased with the temperature due to recovery, and subsequently increased mainly due to the phase transformation. During the hot stamping tests, qualified parts could be formed successfully at heating temperatures ranging from 750 to 850°C. The forming failed at lower temperatures due to the limited ductility of the material. At temperatures higher than 900°C, extensive phase transformation of α to β occurred during the heating. During the transfer and forming, the temperature dropped significantly which led to the formation of transformed β, reduction of the formability and subsequent failure. The post-form hardness distribution demonstrated the same tendency as that after uniaxial tensile tests.

Key words: titanium alloys, Ti6Al4V, hot stamping, microstructure

1. Introduction

Demand for low density and high strength materials in the aviation sector has expanded greatly due to ambitious carbon emission and fuel consumption targets. In order to meet these targets, manufacturers have focused on weight reduction via the use of lightweight materials. In the aerospace sector, low strength structural components are commonly produced from aluminium alloys, and high strength structural components are made from titanium alloys [1]. However, the forming of complex-shaped components from titanium alloys is time, energy and cost intensive. The aircraft industry currently uses methods such as superplastic forming [2], superplastic forming with diffusion bonding