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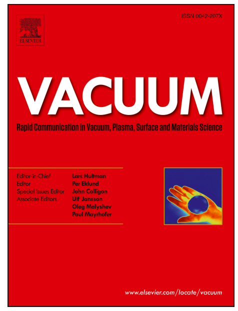

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Zhang Ping, Wang Youqiang

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Effects of Shear Strain and Annealing on the Nano-precipitate phase and Crystal Orientation of 7055 Aluminum Alloy during Cutting Process

ZHANG Ping, WANG Youqiang

School of Mechanical Engineering, Qingdao University of Technology, Qingdao, Shandong 266520, China

Abstract: This paper is intended to examine the effects of shear strain and annealing on the microstructure and crystal orientation of the chips and matrix of 7055 aluminum alloy after three heat treatment processes. High-speed cutting test was conducted on the alloy by shear strain control method to examine the effects of shear strain and annealing on the microstructure and crystal orientation of the chips and matrix of the alloy after peak aging, overaging and solution treatment. The result indicates that, given the same shear strain and annealing conditions, the maximum microhardness of the chips after peak aging was 1.35 times that after overaging; when the shear strain was 3, the microhardness of the chips was 1.3 times that of the matrix after peak aging but only 1.05 times that of the matrix after overaging. Before annealing, when the shear stress was 3, the grain size of the chips after overaging treatment was twice that of the chips after peak aging, and about 1.6 times that after solution treatment. Electron diffraction pattern demonstrates that, under peak aging, when the shear strain was 1, the subgrain misorientation was modest, but when the shear strain was 3 and 5, there was a considerable subgrain misorientation between the center and the surrounding area; under overaging treatment, as the shear strain increased, so did the spot intensity of the diffraction ring around the central spot. When the annealing temperature was 180℃, bulk, spherical precipitates were detected at the grain boundary after peak aging; at the same shear strain, the grain coarsening resistance after overaging treatment was greater than that after peak aging. Under solution treatment, the microhardness of the chips at any shear strain increased and then decreased as the annealing time increased with a turnaround time of approximately 2h; when the annealing time increased to 19h, the matrix displayed roughly the same microhardness as the sheared chips.

Keywords: 7055 aluminum alloy; Shear strain; Annealing; Nano-precipitate phase; High-speed cutting; crystal orientation

1. Introduction

As a new, ultrahigh-strength aluminum alloy, 7055 is already the first choice of a lightweight material for its many advantages. Its high corrosion resistance has also made it a popular material for aerospace applications, where it is most frequently used for main structural members. Given the large volume and high material removal rate of these members, the material is typically machined by high-speed cutting[1-3], which is a matter of thermocoupling high-strain plastic deformation. During the cutting process, the cutting heat exposure of the cutting-layer metal will lead to considerable changes in the mechanical properties and microstructure of the metal[4]. As micro-variations in the cutting layer metal eventually will change with the generation of the chips, investigating the chipping mechanisms of 7055 aluminum alloy during cutting process is