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Investigations on microstructure and grain orientation uniformity of Ti-17 titanium alloy under different hot deformation modes

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Abstract

In this paper, the microstructure and grain orientation uniformity of Ti-17 titanium alloy under high temperature compression and axial upsetting and drawing processing (AUDP) conditions were investigated by light microscopy (LM) and electron backscatter diffraction (EBSD) technique. The relationship between the microstructure and grain orientation evolution in different hot working modes and hot deformation parameters was systematically investigated. The results indicate that grain size of β phase affects the precipitation behavior of α phase, the smaller β grains resulting in a higher grain misorientation angle, thereby improving grain orientation uniformity of the material. AUDP can obtain finer uniformity microstructure, but the homogeneity of β phase grain orientation has not been obviously improved and the anisotropy of the β matrix still exists. Subsequently, when annealing in the (α+β) region, the grain growth and the interface become more clearly, but the annealing process cannot eliminate the macro-zones induced by the β phase with a grain orientation concentrated area.

Keywords: Ti-17 alloy; deformation; microstructure; grain orientation

1. Introduction

Titanium alloys are important structural material used in the aerospace industry because of their excellent corrosion resistance, high specific strength and service temperature. However, due to their low deformation coefficient, high cutting temperature and severe surface hardening phenomenon, the manufacturing processing of titanium alloys is very difficult, as demonstrated by Weiss et al. (1998) and Williams et al. (2003). In order to improve their processing performance, the previous work focused on the study of thermal processing parameters on the microstructure and grain orientation evolution of titanium alloys (Mironov et al.,2009; Furuhara et al.,1996; Glavicic et al., 2003). Ti-17 alloy becomes the mainstream of the current study due to superior processing and service performance. Mu et al. (2013) indicated that the hot deformation strain rate affects the volume fraction of α phase more obviously than the deformation temperature when hot working in the two-phase region of Ti-17 alloy, is one very novel point of view. The mechanical properties of titanium alloys are depending on the microstructure. The typical microstructure of the Ti-17 alloy in practical application is that the equiaxed primary α (α_p) phase evenly distribute on the β matrix. In the process of thermal deformation, the two phases have deformation coordination. For example, the equiaxed microstructure has higher fatigue properties than lamellar microstructure, but poor fracture toughness. Thus, how to obtain the matching of α and β phase is a subject of common concern in the engineering field.

In recent years, with the deepening of research on the fine structure of materials, the influence of thermal processing parameters on the microstructure and grain orientation uniformity and in response to the signal nondestructive testing (NDT) has become a hot topic of titanium performance optimization. However, titanium alloy can be homogenous in microstructure and heterogeneous in local grain orientation distribution. Germain et al. (2008) reported that texture heterogeneities induced by subtransus processing of TIMETAL 834 near-α titanium alloys. This contribution shows