ABSTRACT

Ti-5Al-5Mo-5V-3Cr alloy is a recently developed high strength β Ti alloy for potential applications in aircraft structural components. Boeing with Russian Ti producer VSMPO jointly developed this alloy and used as landing gear material in their recent aircraft Boeing 7E7. Even after introducing new material into an actual application, there remain a lot of scope for further research to obtain even better properties and/or wider processing window out of the same material by studying various aspects of microstructure and texture evolution through various thermomechanical processing (TMP) and their effects on properties. For improved mechanical properties, microstructure with uniform distribution of fine β grains is required. Hence, understanding β phase recrystallization behaviour as a function of deformation condition and post deformation annealing temperature is important to arrive at the right thermo-mechanical processing window for achieving uniform fine β grain distribution. In the manufacturing operation, a component is subjected to heat treatments usually at the last stage after shaping operations, namely, forging and machining are completed. A better understanding of the dimensional change during heat treatment process is necessary for keeping tolerance in the design of components. Dimensional change happens not only due to the thermal expansion, but also because of phase transformation, recovery, recrystallization of the phases and removal of residual stress. Study of dilatometric response during heating process can give information about such dimensional change and its cause. Also, material's mechanical behaviour as a function of microstructure under tensile and cyclic loading is very important to understand in light of underlying deformation mechanism for engineering microstructures with improved properties.

These aspects have been studied for Ti5553 alloy in the present work. A thermo-mechanical processing window in terms of % deformation, finish temperature of deformation and post deformation annealing temperature has been arrived at to obtain a fine β grain distribution in Ti5553 alloy. For the first time a detailed dilatometric study along with microscopic observation has been carried out for the present alloy. Dilatometric responses have been analyzed in terms of α phase dissolution, recovery, recrystallization of both α and β phases and release of anisotropic residual stress present in the starting material. The present investigation

has shown that the dilatometric examination coupled with microscopic observations can be employed for identifying the temperature ranges over which these processes occur – the information relevant for devising thermo-mechanical treatments of this alloy. A detailed TEM based investigations of deformation micro-mechanisms along with study of eventual failure mechanisms have been carried out to explain different tensile responses of different microstructures, one with full β, and the other two of β annealed microstructures with small vs. large aspect ratios of α in Ti-5553 alloy.LCF responses of Ti5553 alloy for various microstructures of β annealed and bimodal have been explained in terms of corresponding deformation micro-mechanism and failure mechanism.

Keywords: Ti-5Al-5Mo-5V-3Cr alloy, Dilatometry, Thermomechanical processing, Recrystallization, Tensile, Low Cycle Fatigue, Deformation mechanism.