Effect of Heat Treatment on the Workability of Hot Isostatic Pressed TNM-B1

Johan Andreas Stendal[1, a)], Mark Eisentraut[1, b)] Markus Bambach[1, c)] Irina Sizova[1, d)] Sebastian Bolz[1, e)] and Sabine Weiß[1, f)]

[1]Panta Rhei Gebäude,
Konrad-Wachsmann-Allee 17,
03046 Cottbus, Germany

[a)]Corresponding author: Stendal@b-tu.de
[b)]Mark.Eisentraut@b-tu.de
[c)]Bambach@b-tu.de
[d)]Sizova@b-tu.de
[e)]Sebastian.Bolz@b-tu.de
[f)]Sabine.Weiss@b-tu.de

Abstract. Titanium aluminides (TiAl) hold attractive material properties for a range of industries. Specifically, hot forged TiAl turbine blades are seeing implementation in commercial aircraft engines due to their reduced weight and similar strength as compared to the conventional nickel-based blades. Usually, these blades are hot forged from cast ingots, which have undergone hot isostatic pressing (HIP) to remove casting porosities. However, the low workability of the HIPed microstructure can cause long processing times and excessive wear on the costly molybdenum tools due to high forging stresses. These factors lead to a high unit cost for TiAl forgings. This unit cost can be reduced by introducing a heat treatment step to the industrial forging process. In this work, a new two-step heat treatment strategy (1300 °C for 1 h, 1100 °C for 5 h) is developed with the aim of softening the HIPed microstructure to increase workability of the TiAl alloy TNM-B1 for hot forging. The samples were tested inside the industrial forging window of TNM-B1 at the temperatures 1125, 1150, 1175 and 1200 °C, with a strain rate of 0.005 s^{-1}. The flow stress, microstructure characteristics and damage behavior of the heat-treated samples were analyzed and compared to their HIPed counterparts. The results revealed a significant reduction in flow stress for the heat-treated samples, especially towards the lower temperatures. SEM images indicated that a fraction of the less deformable lamellar colonies in the HIPed microstructure had decomposed due to the heat treatment. In addition, a higher degree of precipitation of the highly deformable β-phase was observed in the heat-treated samples. The damage behavior results of the HIPed and heat-treated samples showed little to no damage after forging in both material states. The main conclusion drawn from this investigation is that the developed heat treatment step can induce higher workability for TNM-B1 forgings, which in turn can contribute to reducing the unit cost by reducing tool wear or allowing faster forging speeds.