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Physical simulation of hot plastic deformation of TiBw/Ti composites

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ABSTRACT

The TiBw/Ti composites with network microstructure exhibited a superior combination of strength and ductility. Moreover, the service temperature of the composites can be increased by 100–200°C. Therefore, it is significant to study the microstructure evolution of the network structured composites and optimize deformation parameters by physical simulation of hot plastic deformation in order to guide their forming and applications. The hot simulation compression was performed on TiBw/Ti6Al4V and TiBw/Ti60 (Ti60:Ti–5.8Al–3.4Zr–4.0Sn–0.4Mo–0.4Nb–0.4Si–0.06C) composites with network microstructure in the temperature range of 900–1100°C and strain rate range of 0.001–10 s^{-1}. The stress–strain curves, deformation behaviors, and mechanisms were analyzed for the TiBw/Ti composites. The constitutive equations and processing maps of the novel composites were constructed using the compression data based on the dynamic material model (DMM). The processing map exhibited two domains with peak efficiencies: one is in the $\alpha + \beta$ range, and the other is in the β range. The domain in $\alpha + \beta$ range indicates superplasticity, α phase DRX, while the domain in β range does safe regions being DRX of β phase. In addition, with decreasing strain rates, low angle grain boundaries (LAGBs) in α phase were decreased and transformed into high angle grain boundaries (HAGBs), which can result in globularization of α phase. When the composites were deformed at low strain rate, new grains are not formed by classical nucleation mechanism; the recrystallized microstructure develops instead by the progressive transformation of sub grains (LAGBs) into new grains.

KEYWORDS: TiB whisker, Ti alloy, composites, plastic deformation, processing map