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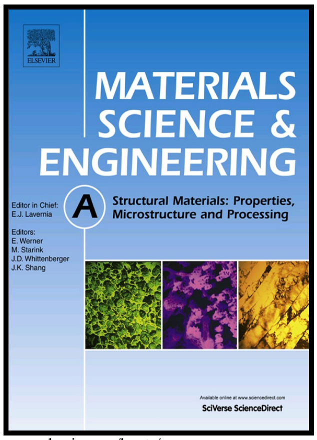

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Coupled effects of deformation and cooling on the evolution of primary and secondary alpha of two-phase Ti-alloys

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Abstract

The concurrent hot deformation and temperature drop is an important phenomenon in hot forging of two-phase titanium alloys. Understanding the microstructure development in this process is critical to control microstructure and tailor the mechanical properties. For initial equixed structure, primary and secondary alpha evolution, and deformation behavior are revealed by designing concurrent hot compression and controlled cooling experiments. The results show that the growth of primary alpha phase is retarded by deformation at low cooling rate. The morphology of primary alpha cannot be changed by deformation. However, concurrent hot deformation and slow cooling can promote the precipitation of secondary alpha phase. The equixed secondary alpha can be obtained at low strain rates, which can be ascribed to the change in the mechanism of $\beta\rightarrow\alpha+\beta$ phase transformation by EBSD orientation analysis, the strain weakened anisotropic growth and globularization of alpha laths. Furthermore, without considering the change of alpha phase fraction, the relative difference between calculated and experimental flow stress even can reach 53.4%, which confirms that phase fraction has a significant influence on rheology. Moreover, the strength of transformed beta matrix is improved greatly when the precipitation of secondary alpha is considered. Finally, it can be found that flow stress increases with strain in approximately sigmoidal way. This is due to that temperature drop and increasing phase fraction lead to the increase of flow stress, whereas the rotation and globularization of secondary alpha laths can cause flow softening. The flow stress increases obviously with cooing rate, which can be attributed to fine alpha laths and significant Hall–Petch strengthening effect.