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论文

长期时效对GH4169合金动态拉伸变形行为的影响

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摘要: 研究了长期时效对GH4169合金的显微组织和动态拉伸性能及变形行为的影响规律及机制. 结果表明, 应变速率为10^1-10^2 s^{-1}时, 合金强度受时效时间影响显著, 断裂延伸率随时效时间的延长呈降低趋势, 在时效500 h后基本保持不变; 高应变速率(10^3 s^{-1})条件下, 长期时效对合金强度无明显影响, 而断裂延伸率受时效时间的影响显著, 长期时效造成的合金塑性劣化现象提前发生. 高应变速率变形过程中, 位错运动受阻来不及释放, 在时效0-1000 h范围内, 合金未出现强化相峰值尺寸效应, 强度受时效时间的影响并不明显. 长期时效后GH4169合金晶界δ相附近无析出带的产生, 导致动态载荷下晶界塑性变形的协调能力降低, 应变速率为10^3 s^{-1}时, 合金塑性在短时间时效后迅速下降.

关键词: GH4169合金 长期时效 动态载荷 变形行为

EFFECT OF LONG-TERM AGING ON DYNAMIC TENSILE DEFORMATION BEHAVIOR OF GH4169 ALLOY

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Abstract: In traditional aeroengine manufacturing industry, the variation and mechanism of the mechanical property of superalloy used for rotating parts under the actual dynamic load is not given full considerations during its structure design. The mechanical property and deformation behavior of the alloys under the dynamic load have significant difference compared with that under the static load, and therefore the study on the deformation behavior of the alloy under the dynamic load is important for the safety of rotating parts used under the severe service conditions. The effect of microstructural changes of long-term aging GH4169 alloy on the mechanical properties through tensile testing at strain rates ranging from 10^1 to 10^3 s^{-1} was examined in this paper. The tensile deformation behavior of the alloy and the mechanisms were also discussed. The results showed that the strength of the alloy depends strongly on the aging time, the fracture elongation decreases with the increasing aging time and remains unchanged when aged for 500 h when tensile tested at the strain rates ranging from 10^1 to 10^3 s^{-1}. And when the strain rate is high up to 10^3 s^{-1}, the elongation depends strongly on the aging time and the degradation of ductility by the long-term aging happens ahead of time, but the aging time has no obvious effect on the strength of the alloy. Through tensile testing at the strain rate of 10^3 s^{-1}, it is too late to release the blocked dislocation motion in the way of dislocation decomposition or climb in the alloy. And there is no peaking size effect of the strengthening phase in the alloy with the aging time ranging from 0 to 1000 h and there is no obvious effect of the aging time on the strength of the alloy. The ability of accommodation of plastic deformation by grain boundaries reduces under the dynamic loads due to the existence of precipitate free zones around δ phase at the grain boundary in the alloy by long-term aging, and thus the ductility of the alloy by aging for a shorter time decreases rapidly when tensile tested at the strain rate of 10^3 s^{-1}.

Keywords: GH4169 alloy long-term aging dynamic load deformation behavior

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