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论文

Delta工艺中Inconel 718合金中δ相的演变机制

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摘要:

针对Inconel 718合金的Delta工艺, 采用金相显微镜、扫描电镜和定量X射线衍射技术研究了变形温度为950℃、应变速率为0.005 s^{-1}的等温压缩变形中δ相的演变机制. 结果表明: 在变形前的加热和保温阶段, 时效处理过程中晶内析出的颗粒/短棒状δ相全部溶解消失, δ相含量由8.14%降低为7.05%; 在变形过程中δ相发生了溶解, 含量由7.05%进一步降低为5.14%; 由于变形断裂和溶解断裂的综合作用, 片层/长针状δ相发生球化, 由片层/长针状δ相转变为颗粒/短棒状δ相; 在变形量最大的芯部, 片层/长针状δ相全部消失, 颗粒/短棒状δ相分布于晶内与晶界.

关键词: Inconel 718合金 Delta工艺 δ相 变形 球化

EVOLUTION OF δ PHASE IN INCONEL 718 ALLOY DURING DELTA PROCESS

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Abstract:

Superalloy Inconel 718 is an important material used for aero–engine high temperature turbine disks. The grain refining of Inconel 718 becomes critical because of the improvement in the quality and reliability of aero–engine. Inconel 718 turbine disks are manufactured by multi–stage hot deformation processes, in which the recrystallized grain grows up in next passes. Therefore, it is difficult to obtain a uniform and refined microstructure by recrystallization refining. The δ phase in Inconel 718 can control grain size through the strong pinning effect. Thus, the Delta process (DP) has been applied for the forging of Inconel 718. In this paper, for the DP of Inconel 718, the evolution of δ phase during isothermal compression deformation at temperature of 950℃ and strain rate of 0.005 s^{-1}, was studied by using optical microscope (OM), scanning electron microscope (SEM) and quantitative X–ray diffraction (XRD) technique. The results show that spherical or rod–shaped δ phase particles in the interior of grains precipitated in the aging treatment disappear during the heating and holding time before deformation, and thcontent of δ phase decreases from 8.14% to 7.05%. Dissolution of δ phase occurs during the deformation, and the content of phase decreases from 7.05% to 5.14%. The spheroidization of plate–like or needl–like δ phase takes place due to the effect of deformation and dissolution breakages, and the plate–like or needle-like δ phase transferrs to sphrical or rod–shaped δ phase. In the centre with the largest strain, the plate–like or needle–like δ phase disappears and spherical or rod–shaped δ hase appears in the interior of grains and grain boundais.

Keywords: Inconel 718 alloy Delta process δ phase deformation spheroidization

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