

论文

多向压缩变形及退火制备超细晶铜合金

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摘要: 通过OM, TEM和SEM/EBSD研究了QBe1.7铜合金室温多向压缩变形及973 K退火后的微观组织及其取向演化规律. 结果表明: 室温变形时,其真应力-累积真应变(σ - $\Sigma\varepsilon$)曲线因动态回复而呈类似稳态流变特征, 随变形道次的增加组织内部产生了大量的亚晶,但均匀弥散分布的细小析出物的存在严重抑制了动态再结晶的进行,累积变形至 $\Sigma\varepsilon=4.8$ 时仍未出现细晶; 而在中等变形程度下($\Sigma\varepsilon=2.4$)通过退火处理可获得平均晶粒尺寸仅0.8 μm 左右的超细晶组织. 超细晶主要是由变形所产生的中低角度晶界迅速转变为包含大量孪晶界的高角晶界演化而成. 根据晶粒尺寸变化可把退火过程分为回复、晶粒急剧细化和晶粒正常长大3个阶段.

关键词: 铜合金 多向压缩 退火处理 超细晶 再结晶

PREPARATION OF ULTRAFINE - GRAINED COPPER ALLOY PROCESSED BY ANNEALING TREATMENT AFTER MULTI - DIRECTIONAL COMPRESSION

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Abstract: Ultrafine grained (UFG) metallic materials arouse a great interest due to their great mechanical properties. Through the way of severe plastic deformation (SPD), including equal channel angular pressing (ECAP) and high - pressure torsion (HPT), the UFG materials obtained can be of obvious improvement in strength but of decrease in their thermal stability and ductility. In this article, the authors manage to obtain an UFG QBe1.7 copper alloy with great comprehensive properties by annealing the samples after being multi - directional compressioned (MDCed) at room temperature. The multiple tests were carried out using rectangular samples with consequent changing of loading direction in 90^o through three of mutually perpendicular axes from pass - to - pass. The deformed and subsequent annealed microstructures were investigated by OM, TEM and SEM/EBSD metallographic observations. The integrated flow curves plotted over a number of compression passes increase to a maximum at moderate strains of 1 to 2 followed by steady - state - like flow at high cumulative strains. Fine grains were not observed even at a higher cumulative stain of $\Sigma\varepsilon=4.8$, although there were many sub - grains when the samples were deformed to $\Sigma\varepsilon=2.4$. This indicates that the dynamic recrystallization or recovery was completely inhibited by fine precipitates. Static recrystallization (SRX) of the MDCed structure at 973 K was also investigated. With the increment of cumulative strains, the effect of grain refinement became more obvious, but the thermal stability was getting worse. At a medium strain of $\Sigma\varepsilon=2.4$, the minimal grain size of 0.8 μm can be developed with an excellent combination property. The formation of ultrafine grain is characterized by large - angle boundaries developed from low to medium boundaries. The change of the average grain size with annealing time can be divided into three stages: a recovery period for grain refinement, rapid grain refinement and normal grain growth.

Keywords: copper alloy multi - directional compression annealing ultrafine grain recrystallization

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