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论文

预变形对Zr-Sn-Nb合金淬火时效晶粒及析出相的影响

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摘要: 采用SEM附带的背散射电子通道衬度(ECC)像、二次电子(SE)像及能谱(EDS)分析技术,研究了 β 相水淬后预变形处理对Zr-S-Nb合金在时效过程中再结晶和第二相析出的影响规律.结果表明,未引入预变形直接时效时所得组织中再结晶晶粒尺寸粗大且形状不规则,第二相粒子尺寸差异也较大,其中尺寸大的第二相粒子为含Cu的 Zr_3Fe ,主要沿原 β 晶界分布;预变形后再时效的组织中再结晶晶粒显著细化且尺寸均匀,第二相粒子尺寸差异减小,大尺寸的 Zr_3Fe 粒子主要沿 α 再结晶晶界分布.无论有无预变形或时效时间长短,晶粒内部析出相均为弥散分布的小尺寸 $Zr(Fe, Cr, Nb)_2$ 粒子.引入预变形会减弱沉淀相沿晶界析出和急剧长大的倾向,使锆合金的微观组织和第二相分布特征改变.

关键词: 锆合金 预变形 第二相粒子 再结晶

EFFECT OF PRE-DEFORMATION ON GRAINS AND PRECIPITATES OF Zr-Sn-Nb ALLOY DURING AGING

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Abstract: Zirconium-based alloys are being used as fuel cladding and structural materials for nuclear reactors since they have a good irradiation stability, corrosion resistance and acceptable mechanical properties in a reactor environment. Recently, more advanced zirconium-based alloys are required for enhanced operating conditions such as an increased burn-up and higher operation temperatures. Therefore, the development of advanced zirconium alloys for a fuel cladding is being progressed in various countries. Among the developed new zirconium alloys, a low Nb containing alloy series designed by China is a group of promising cladding material. For the new alloy system, optimum manufacturing processes are significant factors to improve properties and need urgently to be established. In this work, electron channeling contrast (ECC), secondary electron (SE) imaging and energy dispersive spectroscopy (EDS) analyzing techniques are employed to investigate the effect of pre-deformation following β -quenching on recrystallization and precipitating behavior of a new Zr-Sn-Nb alloy during aging. The results show that remarkable differences exist between the microstructure of specimens with and without pre-deformation prior to aging at the same temperature (650 °C). Specimens aged without pre-deformation present extremely heterogeneous recrystallized grains that generally own irregular shape. The size discrepancy between the intragranularly fine $Zr(Fe, Cr, Nb)_2$ precipitates and the larger ones, which is Cu-containing Zr_3Fe particles and distribute along the conserved prior β grain boundaries, are distinct. While for specimens aged following 20% pre-deformation, the recrystallized α -grains are evidently fined and homogenized. The size discrepancy between the two sorts of precipitates decrease as well and the larger ones change to distribute along recrystallized α -grain boundaries. Therefore, the introduction of pre-deformation is able to change markedly the characteristics of microstructure and second phase particles distribution and further be utilized to obtain preferred microstructure.

Keywords: zirconium alloy pre-deformation second phase particle recrystallization

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