金属学报 2011, (12) 1541-1549 **DOI**: 10.3724/SP.J.1037.2011.00382 **ISSN**: 0412-1961 **CN**: 21-1139/TG

论文

Ti和Mn含量对CSP工艺Ti微合金钢析出特征与强化机理的影响

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摘要: 利用电子背散射衍射(EBSD)技术和高分辨透射电子显微镜(HRTEM)对不同Ti和Mn含量的CSP工艺Ti微合金钢进行了显微组织分析与析出相特征观察. 结果表明: 与Ti和Mn含量较低的钢相比, Ti和Mn含量较高的钢中, 不仅小角度晶界分布比例较高, 同时颗粒尺寸在 10 nm以下的TiC粒子析出数量显著增加, 而较大尺寸的M_3C相(Fe_3C)析出数量却有所减少. 此外, 强化机理分析表明, 细晶强化与位错强化对两 实验钢的屈服强度贡献最大,而沉淀析出强化是造成两实验钢强度差别的主要原因.

关键词: CSP Ti微合金钢 强化机理 力学性能

EFFECTS OF Ti AND Mn CONTENTS ON THE PRECIPITATE CHARACTERISTICS AND STRENGTHENING MECHANISM IN Ti MICROALLOYED STEELS PRODUCED BY CSP

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Abstract: As an advanced manufacturing technology to produce hot rolled strips, compact strip production (CSP) process was developed at the end of last century and has been widely applied due to its high efficiency and low cost. Compared with the traditional technology, the advantages of CSP technology benefited from the refinement of austenitic grains and precipitation strengthening in the steels. This is because cooling rate is higher during the solidification of slab and the direct charging slab temperature is also higher in the CSP process, resulting in much higher solute contents in the solid solution before hot rolling than expected by the experiences from traditional steel production. So far, the Ti microalloyed steels produced by CSP process already have good performance and have drawn much attention on Ti precipitate behaviors and strengthening mechanism. However, the influence of alloying element Mn on the Ti microalloyed steels produced by CSP, especially the synergistic effect of Mn and Ti, was rarely reported. Therefore, in this work the microstructure and precipitate characteristics of two Ti microalloyed steels with different Ti and Mn contents produced by CSP process were studied by electron backscatter diffraction (EBSD) technology and high resolution transmission electron microscope (HRTEM). The results show that the steel with higher Ti and Mn contents has a higher frequency of small－angle grain boundary. Furthermore, the weight fraction of TiC precipitates with particle size smaller than 10 nm increases significantly, from 7.6% in the lower Ti and Mn steel to 26.1% in the higher Ti and Mn steel. However, the amount of Fe_3C precipitates decreases markedly. In addition, the strengthening mechanism analysis of the two tested steels show that grain refinement strengthening and dislocation strengthening make great contribution to the yield strength, while the precipitation strengthening is the primary reason which causes the difference in the strength between two tested steels.

Keywords: compact strip production (CSP) Ti microalloyed steel strengthening mechanism mechanical properties

收稿日期 2011-06-20 **修回日期** 2011-10-31 **网络版发布日期** 2011-12-29

DOI: 10.3724/SP.J.1037.2011.00382

基金项目:

国家重点基础研究发展计划资助项目 2010CB630805

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