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论文

ECAP变形下304L奥氏体不锈钢的形变诱导马氏体相变

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摘要:

研究了304L奥氏体不锈钢在严重塑性变形(等通道转角挤压, ECAP)下发生形变诱导马氏体转变的微观特征, 包括形核特征、长大方式和相变晶体学, 探讨了粗大晶粒和亚微米晶粒发生马氏体相变的异同和微观机理. 结果表明: 粗大奥氏体晶粒发生相变时, 马氏体主要形核于微观剪切带(包括层错、变形孪晶和ε相等)的相互交割处, 马氏体与奥氏体之间为K---S(Kurduumov---Sachs)关系, 而不是西山(Nishiyama---Wassermann)关系; 亚微米奥氏体晶粒发生相变时, 马氏体则多在奥氏体晶界处形核, 马氏体与奥氏体之间仍为K---S关系.

关键词: 奥氏体不锈钢 等通道转角挤压 亚微米晶 马氏体相变 微观机理

STRAIN--INDUCED MARTENSITIC TRANSFORMATION IN 304L AUSTENITIC STAINLESS STEEL UNDER ECAP DEFORMATION

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Abstract:

The strain–induced martensitic transformation (SIMT) is considered to be an effective route to enhance the mechanical properties of metastable austenitic steels. Recently, it was found that the SMIT was favourable for the formation of nanocrystalline microstructures in some austenitic steels and titanium alloys, by using the technique of severe plastic deformation (SPD) for grain refinement. It is well known that austenitic stainless steel is sensitive to martensite transformation under plastic deformation at low temperature. However, the mechanisms of SIMT in austenitic stainless steel (AISI 304 series) under SPD, particularly the transformation mechanisms in small grains with sizes of submicronmeter and nanometer, are still lack of investigation. Equal channel angular pressing (ECAP) is one of the popular methods of SPD, which can produce bulk nanostructured metallic materials without any reduction in the cross–sectional area of specimen. It has been clarified that the shear deformation imposed by ECAP was the most effective route to trigger SIMT in austenitic stainless steel in comparison with uniaxial tension and compression. In this paper, the SIMT in 304L austenitic stainless steel was invesigated under ECAP deformation at room temperature, in order to reveal the mechanisms of nucleation, grwth and crystallography of strain–induced martensite. The microstructures of strain–induced martensite during ECAP deformation were carefully examined by X–ray diffraction and transmission eectron microscope (TEM). It was found that in the case of coarse austenitic grains, the strain–induced marteniste nucleated at the intersection of deformation bands (including the bundles of stacking faults, deformation twins and platelets of epsilon phase) and kept the K–S (Kurdjumov–Sachs) but not the Nishiyama–Wassermann orientation relationships with austenitic grains. While in the case of small austenitic grains with sizes of several hundred nanometers, the strain–induced martensite preferred to nucleate at grain boundaries and grew up via swallowing the matrix of austenite. The martensitic grains followed the K–S crystallographic relationships with austenite too. Furthermore, the new nanocrystallne martensitic grains were easily rotated against each other by shear deformation, which prevented the coalescence of martensitic grains and was beneficial for the formation of nanocrystalline stuctures. Accoring to the K–S orientation relationship, the {110} planes of martensite are converted from the {111} lanes of austenite, keeping the <110> direction of martensite parallel to the <111> direction of austenite as well. The difference and mechanism of SIMT occurring in coarse austenitic grains and submicron austenitic grains were discussed in detail.

Keywords: austenitic stainless steel equal channel angular pressing submicron grain martensitic transformation microscopic mechanism

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