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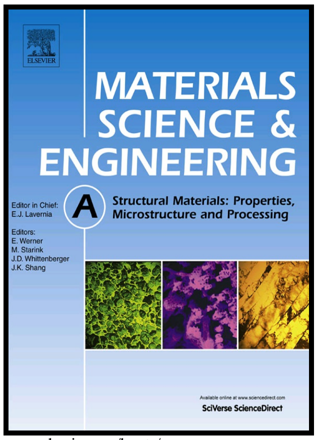

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Effects of prior microstructures and deformation parameters on the ultra-refining uniformity of Ti-Mo ferritic steel

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Abstract:

Samples with different prior microstructures, quasi-polygonal ferritic (QPF) matrix and polygonal ferritic (PF) matrix, were compressed at 500 ℃ with different strain rates. As for the QPF matrix, its microstructure more tend to be compressed and refined under small strain rate, while it is opposite for the PF matrix. Increase of deformation temperature to 600 ℃ and 700 ℃ illustrates that during cDRX process, extending of geometric necessary boundaries (GNBs) increases the flow stress whereas the rearrangement of geometric necessary dislocations (GNDs) mainly causes the softening phenomenon. Additionally, extending of GNBs in prior grains firstly facilitates the increase of texture intensity on certain orientations, then the texture intensity decreases with further conduct of continuous dynamic recrystallization (cDRX) process, during which the subgrains mainly rotate along <001>//SD or <111>//SD and make orientations distributed more randomly within fiber textures. Deformation at 600 ℃ shows better refining effect and the average grain size can be refined to submicron scale, however, deformation at 700 ℃ presents better ultra-refining uniformity that the area fraction of ultra-refined regions can reach 94.8 % with an average grain size of 1.1 μm. TEM observation clarifies that with the increase of deformation temperature, low angle boundaries (LABs) will replace dislocation walls dividing the prior grains and show better extending ability. Activation energy of the cDRX process also been estimated and it is about 768 KJ/mol.

Keywords: Ferrite; Ultra-refinement; Compression; cDRX

1. Introduction:

Ultragrain refinement could bring significant improvements on the mechanical properties of metal materials, thus various approaches have been used to refine the average grain size [1-3]. Grain refinement of ferritic matrix is firstly achieved through increasing of cooling rate within the γ-α phase transition process, during which large degree of supercooling facilitates the nucleation rate, thereby limiting the growth of grain. Following that, deformation induced ferrite transition (DIFT) is applied and the nucleation rate is further increased due to the introduction of strain energy [4, 5]. By using these mechanisms, average grain size can be refined to 2~5 μm which is generally regarded as the ultra-refined grains. Additionally, cold (or warm) rolling and annealing process is also adopted to refine the grain size based on the statistic recrystallization process [6]. However, influenced by the abnormal growth [7], it is also hard to achieve a uniformly ultra-refined matrix with smaller grain size.