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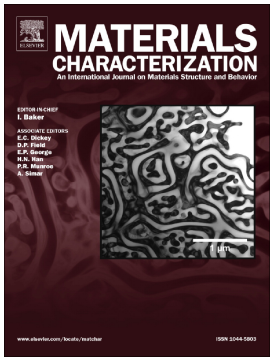

Formation of nanocrystalline structure in pearlitic steels by dry sliding wear

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Abstract: Nanocrystalline grains, whose average size was approximately 35±5nm, were generated in the outermost layer of a pearlitic wheel steel by dry sliding wear. To explore the evolution of nanocrytalline grains, successive observations from the outermost layer of sliding wear to the undeformed matrix were done by scanning electron microscopy(SEM) and transmission electron microscopy (TEM). The investigations showed that the evolution process of nanometer-sized grains in pearlitic wheel steels included four steps: initially, pearlitic plastic deformation took place, lamellar spacing diminished, great amounts of dislocations occurred in ferrite, the thickness of ferrite lamellae decreased and some of ferrite lamellae fractured and dissolved; with increasing strains, considerable cementite started to dissolve into grains, and inside ferrite dislocations accumulated, tangled and formed dislocation walls, which cut ferrite into many short-rod shaped—and even equiaxed shaped dislocation cells; as strains continued to increase, dislocation cells gradually transformed into low-angle sub-boundaries. Accumulation and annihilation of dislocations and rotation of grains induced low-angle boundaries（LABs）to turn into high-angle boundaries(HABs), with the grains having random orientation. At this moment, cementite dissolution was relatively saturated and undissolved cementite particles scattered around the refined ferrite boundaries. Under higher strains and strain rates, refined ferrite grains repeatedly underwent plastic deformation, the formation of dislocation cells and the transformation from LABs to HABs, until finally the size of ferrite grains reached the stable minimum value and the refinement of grains ceased. Meanwhile, cementite continued to dissolve slightly due to dislocation accumulation. When dislocation accumulation rate and annihilation rate reached balanced, the dissolution of cementite ceased.

Key words: nanocrystalline structure; pearlitic wheel steel; formation mechanism; sliding wear