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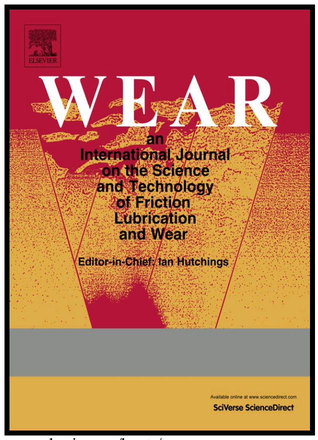

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Dimensionality wear analysis: three-body impact abrasive wear behavior of a martensitic steel in comparison with Mn13Cr2

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Abstract:

Here we systematically investigated the mechanical properties, microstructure and three-body impact abrasive wear behavior of martensitic steel and traditional Hadfield steel (i.e. Mn13Cr2). Compared with Mn13Cr2, the martensitic steel showed better wear resistance with 1335 MPa higher tensile strength, 1007 MPa higher yield strength, 305 HV higher initial hardness, 34.5%~79.0% less wear loss. Furthermore, a dimensionality wear analysis method was proposed to explain the wear behavior from one to four dimensions. One dimensional wear (i.e. phase transition wear) proposed that twining, high density dislocations, retained austenite phase transformations were the strengthening mechanism of martensitic steel while entangled dislocations and stacking faults were the work hardening mechanism of Mn13Cr2. Two dimensional wear (i.e. surface wear) suggested that strain fatigue, cracks, furrow, press-in abrasive and extruded accumulation were the main wear mechanisms of martensitic steel. While those of Mn13Cr2 were press-in abrasive, furrow, strain fatigue, cutting, extruded accumulation and delaminated crater. Three dimensional wear (i.e. macro wear) viewed that the martensitic steel wore in a thin film two dimensional plane surface on the macroscopic scale. However, Mn13Cr2 wore in a three dimensional concave surface with indispensable height and showed one more dimensional wear than martensitic steel.

Keywords: Impact wear; three-body abrasion; martensitic steel; hardness; wear mechanism

1. Introduction

The rapid development of modern heavy industry has caused serious materials wasting. Among the many factors that expend materials, wear damage is one of the most common failure types of mechanical parts in service [1-4]. As a usual wear mode, abrasive wear widely exists in mining and mineral processing industries [5-8]. Heavy impact and hard abrasive in abrasive wear mode become a major challenge of higher wear resistance to wear resistant steel.

In the above-mentioned industrial, Hadfield steel, i.e. high manganese steel, is widely used due to its high impact toughness and work hardening capacity [9,10]. However, its disadvantages on strength and initial hardness lead to a short service life in the field of ore crushing, which caused a series of problems including shut down wasting, material wastage and environmental pollution [11].

Thus, a growing interest has recently been focused on developing steels with better wear resistance than traditional Hadfield steel. Chen et al. [12] proposed an N+Cr alloyed Hadfield steel with stronger wear resistance and work hardening capacity than traditional Hadfield steel in high wear loads. Besides, some researchers