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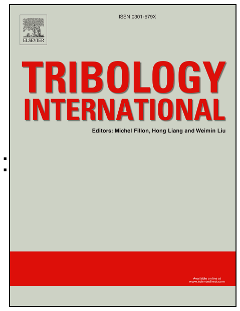

Dry sliding of Hadfield steel single crystal oriented to deformation by slip and twinning: Deformation, wear, and acoustic emission characterization

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Dry Sliding of Hadfield Steel Single Crystal Oriented to Deformation by Slip and Twinning: Deformation, Wear, and Acoustic Emission Characterization

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Highlights

The process of dry friction for Hadfield steel single crystals is studied.
Wear and deformation mechanisms are defined.
The deformation relief evolution is investigated.
The relationship between parameters of acoustic emission signals and wear of single crystals is established.

Abstract. This paper studies Hadfield steel single crystals with the orientation of the normal load axis $[1\ 1\ \bar{8}]$ and friction axis $[4\ 4\ 1]$. The chosen orientation implies that deformation develops by slip and twinning. Analysis of the crystallographic orientation and acting stresses has revealed stages of shear deformation development in slip systems. Consecutive tests of the same duration were conducted to study the evolution of the deformation relief. Using the fast Fourier transform, the median frequency and energy of acoustic emission signals generated at different stages of friction are analyzed. A correlation is established between changes in the acoustic emission parameters and wear of single crystals.

Keywords: Friction, Hadfield steel, Single crystal, Deformation relief, Wear, Acoustic emission.

1. Introduction.

Austenitic Hadfield steel is widely known for its high wear resistance and strain hardening ability. It is used for the production of various products operating under friction conditions with impact loads. The deformation behavior of single and polycrystalline Hadfield steel has been studied under different loading conditions: compression/tension [1–4], high-pressure torsion (HPT) [5], high-velocity compressive loading [6], rolling and HPT [7], cyclic deformation [8], and impact loading [9]. The published investigation results demonstrate that the main deformation mechanisms in single and polycrystalline Hadfield steel can be twinning or dislocation glide, or simultaneous twinning and dislocation glide. One of the strain hardening mechanisms in static tests is the rapid accumulation of high dislocation density [10–12] that generates a short-range stress field promoting strain hardening.

The strain hardening ability of Hadfield steel is also observed in friction. This ability is higher at lower sliding velocities under dry friction [13]. Rolling contact fatigue was shown to change microstructure in the near-surface layer of Hadfield steel [14,15]. Strain hardening of the near-surface layer increased with the growing number of loading cycles until fatigue cracking initiated.

Sliding friction is accompanied by deformation and shearing off of microasperities on the surfaces of contacting bodies. The stress magnitude and temperature on microscopic contact areas are much higher than the nominal stress and bulk temperature [16–18]. The high temperature and stresses cause intense deformation in the surface and near-surface layers of rubbing materials. As a result, the tribolayer is

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