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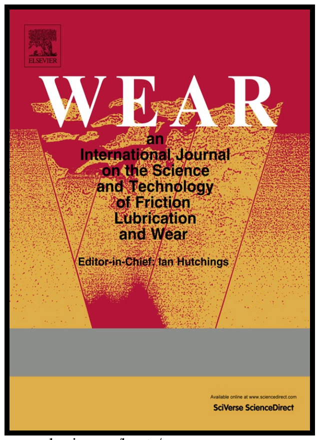

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The tridimensional gradient of microstructure in worn rails – Experimental characterization of plastic deformation accumulated by RCF

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ABSTRACT

The goal of this work is to increase understanding of plastic deformation of the pearlitic microstructure in the wheel/rail contact. The tridimensional gradient of microstructure below the running band of a worn R260 rail is investigated using multi-scale approach based on microstructural observations by optical and Scanning Electron Microscopy (SEM-FEG), microindentation and Electron BackScatter Diffraction (EBSD) investigations. Due to severe plastic deformation, work hardening is progressively experienced by the rail. In the middle of the running band, the pearlitic colonies are fragmented by accumulation of severe shear strain up to 3 mm in depth. At the rail surface, the resulting lamellar structure is elongated and aligned in the shear direction. At a transition depth of 3-4 mm, both fragmented and unaffected pearlitic colonies are observed. In these fragmented colonies, cementite lamellae are heavily bent and partly broken, while ferrite matrix experiences grain refinement. Correspondingly, a strong increase of large angle grain boundaries (LAGB) is measured. The interlamellar spacing progressively decreases from this transition depth to the near surface. This quantitative analysis of the tridimensional gradient of microstructure will contribute to improve modeling of rail plasticity and crack propagation by RCF by including anisotropy of the running band and effect of in-depth microstructure evolution.

Graphical Abstract

Schematic view of the tridimensional gradient of microstructure formed by repeated plastic deformation below the rolling band of a worn R260 rail