Stratified Surface Layers on Rails

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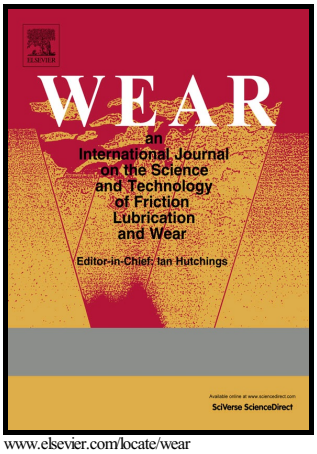

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Abstract

This study examines the properties of stratified surface layers on rails in service and presents a hypothesis explaining their origin. The stratified layer consists of a white etching top layer and a brown sublayer. The metallurgical composition and properties of this sublayer are found to match with that of globular bainite. The occurrence of stratification in the surface layer is explained by the thermomechanical cycle for a material point on the rail surface under wheel-rail contact. Difference in the surface and subsurface cooling rates after reaching the austenitisation temperature may lead, depending on the chemical steel composition, to the generation of two different phases (martensite and bainite) and stratification. The exclusive occurrence of sandwich layers on rails that have been in service is attributed to the hardening of the top layer, leading to a reduced thermal conductivity, which gains relevance at an increasing depth. The granular morphology of the bainitic sublayer, exhibiting weak globular inclusions, facilitates the initiation and the propagation of transverse cracks, thus contributing to the development of RCF.

Keywords: White etching layer (WEL), brown etching layer (BEL), stratified surface layer, thermomechanical cycle, granular bainite, rolling contact fatigue (RCF).

1. Introduction

Although white etching layers (WEL) on rails are a well-known phenomenon for many decades and associated to profile wear, a WEL or the presence of discrete portions of white etching material on the surface of pearlitic

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