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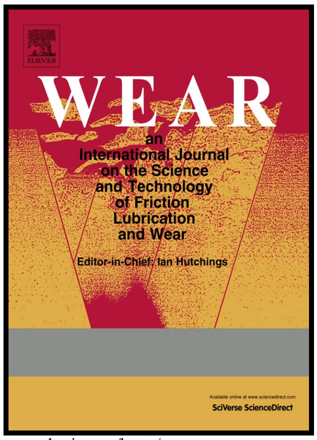

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H.J. Noh, H. Jang

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Friction instability induced by iron and iron oxides on friction material surface

H. J. Noh, H. Jang* (*hojang@korea.ac.kr)
Department of Materials Science and Engineering, Korea University, Seoul, South Korea 02841

Abstract

This study analyzed the effect of ferrous wear particles, which can be transferred from gray iron brake discs to the friction material surface during brake applications, on friction instability. To simulate the chemical change of the sliding surfaces, ferrous particles, such as pure iron, Fe_2O_3, and Fe_3O_4 particles, were embedded on the sliding surface of a friction material, and their friction characteristics were investigated using a scale dynamometer. The results showed that the ferrous particles aggravated friction instability, showing larger stick-slip amplitudes and wider velocity ranges for friction instability than the bare specimen. The embedded ferrous particles increased the static coefficient of friction and produced larger stick-slip amplitudes in the order of Fe_2O_3, iron, and Fe_3O_4, while the friction material without ferrous particles showed the least instability. The surface energy and amount of high-pressure contact plateaus on the sliding surface were attributed to the high friction instability caused by the interfacial adhesion increased by ferrous particles at the sliding interface. This explained the frequent friction-induced noise and vibrations found with a corroded or relatively soft gray iron disc.

Keywords: Gray iron, Iron oxide, Friction instability, Adhesion, Surface energy

1. Introduction

Brake induced noise and vibrations have long been considered major problems by the automotive community. Much effort has been made to remove friction instability by minimizing the friction force oscillation at the sliding interface [1-4] and by controlling the transfer function of the brake system [5-7]. This is because the friction oscillation triggered at the sliding interface can be intensified or diminished by the brake system. However, a robust design of the brake system without friction-induced instability is still considered a challenging task owing to the lack of fundamental understanding of the triggering mechanism.

In order to remove the brake noise and vibrations, recent studies have focused on the sliding interface with particular attention to the mechanical [8-10], morphological [11-13], and chemical properties [14, 15] of the friction material surface based on the knowledge of tribology. They have shown that the composition, strength, and size distribution of the contact plateaus on the sliding surface play crucial roles for friction instability of brake friction materials. This occurs because the contact plateaus are produced by wear debris compaction on the friction material surface and their chemical composition is closely related to the mechanical properties and size distribution of the plateaus [16-21]. In particular, the compositional change of the friction material surface during brake applications has attracted increased attention because a friction material surface with high iron content shows high propensity to friction instability. High noise occurrence from the friction materials after