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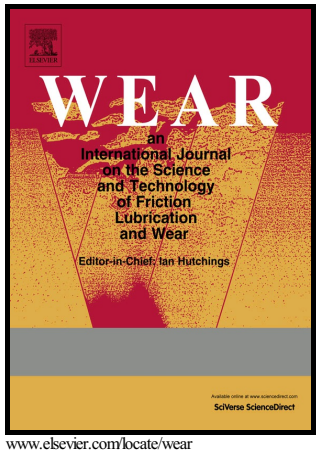


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# Size effect of tire rubber particles on tribological properties of brake friction materials

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Abstract

Size effect of rubber particles on the friction and wear of brake friction materials was investigated since their morphology is often connected to friction instability. Friction materials were fabricated with recycled rubber particles of two different sizes, approximately 75 and 450 μm, and their frictional performance was examined with a reduced-scale brake dynamometer. The results showed that the specimen with small rubber particles showed higher contact stiffness than that with large rubber particles. However, the small rubber particles in the friction materials increased the friction level and friction instability, accompanied by a higher wear rate, which were attributed to the larger high-pressure contact plateaus produced at the sliding interface. This study indicated that the frictional instability of brake friction materials is strongly affected by the contact plateaus and suggested that friction instability can be reduced by regulating the recycled rubber particle size.

Keywords: Brake friction material; tire rubber; size effect; stick–slip

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## 1. Introduction

The brake friction material for an automotive brake system comprises more than 10 ingredients to achieve the desirable braking performance, such as stable friction coefficients, low wear, and low noise generation in a wide range of braking conditions. Each ingredient is chosen for a specific tribological performance, though it often plays multiple roles to realize the required frictional properties. Among the various components used in brake friction materials, the ingredients based on rubber, such as nitrile-butadiene rubber, styrene-butadiene rubber, and tire rubber are often considered as important friction modifiers, owing to their unique viscoelastic properties [1-3]. Rubber particles have been used for many years to increase the compressibility of friction materials in the hope of increasing damping and reducing noise propensity during brake applications. In some cases, there were attempts to use rubbery materials as a base ingredient to achieve comfortable friction performance for railway brakes, owing to their excellent flexibility [4, 5].

The effects of rubber on the tribological properties of brake friction materials have been studied by several researchers. Saffar et al. [6] investigated the effect of rubber on the friction level by

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