7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Ultrafine Particle Emission from HVOF Cermet Coated Brake Rotor

Yezhe Lyu[1)*], Fei Ye[2)], Jens Wahlström[1)] and Ulf Olofsson[3)]

[1)]Machine Elements, Department of Mechanical Engineering, Lund University, Sweden.
[2)]Functional Materials, Department of Applied Physics, KTH Royal Institute of Technology, Sweden.
[3)]Systems and Component Design, Department of Machine Design, KTH Royal Institute of Technology, Sweden.
*Corresponding author: yezhe@kth.se

This study investigates the friction, wear and ultrafine particle (<100 nm) emission from high velocity oxygen fuel (HVOF) cermet coated brake rotors. A commercial grey cast iron (GCI) brake rotor is introduced as reference. A pin-on-disc tribometer is used to compare the friction, wear and particle emission of the HVOF and GCI brakes. Typical urban traffic condition (i.e. contact pressure 0.6 MPa and car speed 50 km/h) are tested in order to study the concentration and size distribution of the particles. Transmission electron microscopy and scanning electron microscopy are used to observe the morphology and composition of the particles.

Keywords (from 3 to 5 max): brake, ultrafine particle, HVOF, TEM, SEM

1. Introduction

Automotive brake rotor is mostly manufactured by grey cast iron (GCI) due to its relatively low cost, excellent thermal properties, machinability, and damping capability. However, GCI brake rotor exhibits excessive wear and noise generation at elevated temperature [1]. Recently, several types of coating techniques have been explored to combat the low wear resistance of GCI. One of the most promising surface treatments is high velocity oxygen fuel (HVOF), which succeeded in applying cermet coating on GCI substrate and largely reduced the wear and airborne particle emission in terms of PM10 [2]. Considering the potential hazardous impact to environment, the ultrafine particles (<100 nm) emitted from HVOF coated brake rotor need fully studied on the morphology, number concentration, size distribution and chemical composition.

2. Methods

2.1. Material

The GCI brake rotor is a commercial product. The HVOF coating, with WC–10Co–4Cr composition, is deposited on the GCI substrate to a final thickness of 70 μm. A commercial low–metallic brake pad material is used as the counterpart.

2.2. Equipment and testing

A pin-on-disc tribometer placed in a one-way ventilated climate chamber is used to simulate the brake contact (see Figure 1). A TSI® Fast Mobility Particle Sizer model 3091 (FMPS) and a DEKATI® Electrical Low Pressure Impactor (ELPI+) are used to explore the airborne particulate matter emissions from testing.

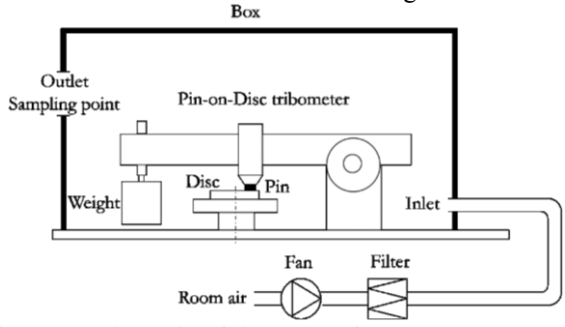

Figure 1: Schematic of the test equipment.

Meanwhile, ELPI+ collects the emitted particles in different size ranges for offline characterization with TEM and SEM. The brake condition corresponds to a typical urban traffic condition. Both brake rotor materials are tested for three times.

3. Results and Discussion

The HVOF cermet coated disc suggests higher concentration of ultrafine particles in the running-in period than the GCI brake (see Figure 2). More information will be found in the full-length paper.

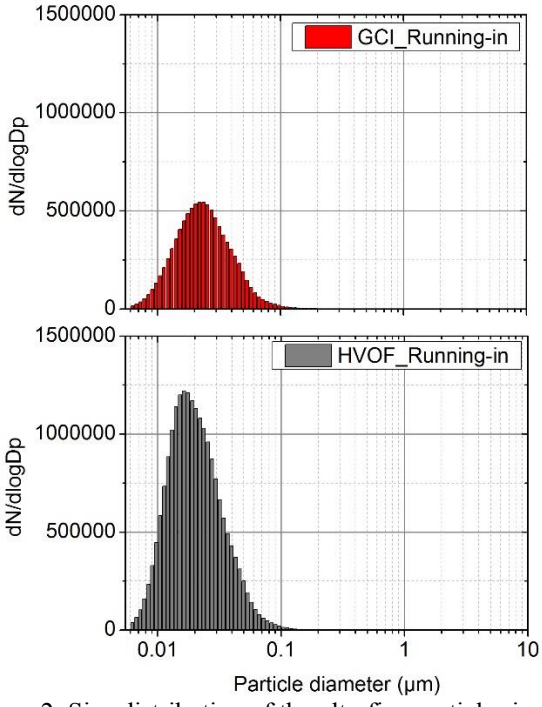

Figure 2: Size distribution of the ultrafine particles in the running-in period.

4. References

[1] Aranke, O. et al., "Coatings for Automotive Gray Cast Iron Brake Discs: A Review," Coatings, 9, 2019, 552.
[2] Wahlström, J. et al., "A Pin-on-Disc Tribometer Study of Disc Brake Contact Pairs with Respect to Wear and Airborne Particle Emissions," Wear, 384–385, 2017, 124–130.