A PIN-ON-DISC STUDY OF PARTICLES EMITTED DURING THE TIRE RUBBER AND ROAD AGGREGATES WEAR TEST

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ABSTRACT
Tire-road wear, a complex phenomenon characterized by the evolution of road surface texture and alterations in tire-road friction, manifests as particulate emission either deposited at the tire-road interface or released into the environment. Although prior research efforts have focused on the collection and characterization of tire and road wear particles (TRWP) [1], offering significant insights into their properties, less is known about the tribological mechanisms governing TRWP generation and the subsequent modifications to tire-road contact conditions.

Addressing this gap, our study introduces a novel test protocol that integrates laboratory wear testing with particle collection to dissect the dynamics of TRWP generation. An approach previously used by authors in the context of braking pads wear laboratory studies [2] was adapted for tire-road interaction. Pin-on-disk tribometer, equipped with an isolated chamber, was used to replicate tire-road contact conditions as accurately as possible on a reduced scale. A particle analyzer and collector, the Electrical Low Pressure Impactor (ELPI) system, was connected to the tribometer chamber for collection and characterization of generated airborne wear particles between 0.007 µm and 10.2 µm.

This methodology is applied to two road aggregates of distinct hardness—limestone and granite—to underscore the influence of road materials properties on wear particle characteristics. Comparison illustrates results of protocol application for materials of different properties, featuring difference in particles deposition and emission rates in connection with surface evolution, as provided on the Figure 1. The evolution of coefficient of friction (COF) is triggered by both surface wear and progressive deposition of wear particles, which are playing a central role in the formation of the third body at the interface.

Post-test, wear particles were collected, enabling a detailed comparison between airborne and deposited wear particles for two surface materials through SEM-EDX analysis, focusing on size distribution, morphology and chemical composition.

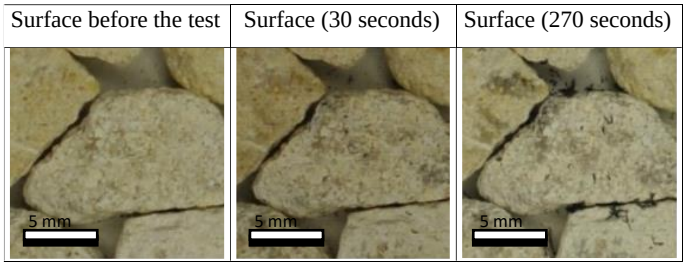

Fig. 1 Sample surface evolution during wear test (limestone)

Results from this comparative analysis reveal significant insights into the interplay between material hardness and TRWP characteristics, highlighting differences in surface deposition patterns, COF evolution, and the morphological and chemical composition of emitted particles. Notably, the study illuminates the relative contributions of ejection and deposition flows at the tire-road interface, advancing our understanding of TRWP's role in environmental particulate pollution. By refining the quantification of TRWP emissions, this research paves the way for more targeted environmental protection measures and contributes to the broader discourse on sustainable transportation infrastructure.

REFERENCES
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