**ABSTRACT**

According to the high loading levels reached in the railway field, on high energy applications, it is expected that the friction materials will change in surface but also in depth. Few studies consider these evolutions, of which it could be shown that they can be consistent but also have a potentially important influence on performances.

Considering a decrease of the friction pad properties related to a kind of material degradation is not enough and remains to be demonstrated. The first difficulty lies in the quantitative identification of these properties during braking cycles, knowing that they are probably not uniform in depth. The second difficulty is the explanation of these evolutions. This is the aim of this work, i.e. identifying properties before and after solicitations and link them with microstructural evolutions of the material.

The proposed methodology is as follows:
- Friction materials being particularly complex it is proposed, for the physical understanding, to work with reduced formulations.
- Tests are conducted in realistic railway braking situations, on an industrial test bench.
- Mechanical and thermal characterizations are conducted, with sample extraction from pads, to determine the corresponding properties. Emphasis is placed on mechanical properties with an original measurement of the depth of the material, by image correlation during compression tests. Comparison is done before and after a cycle of braking.
- Finally, microstructural analyzes are carried out on the depth, using SEM analysis in particular, to explain the structural and micro-structural mechanisms at the origin of the evolution of the properties with the solicitation. It is also analyzed in terms of temperature level in particular, to support explanations.

The major results are:
- the demonstration of a significant evolution of the properties before and after use and the appearance of a deep gradient after use, which is associated with the local solicitation level occurring during the braking;
- the explanation of the evolution of these properties by the microstructural transformations under the braking sequence loading

These are original and quantified for the first time

The limits of this work are technically related to the fact that only one type of material is studied submitted to one type of solicitation. Scientifically it seems that the transformations obtained are related to this solicitation, which is not uniform on the pad, exhibiting the complexity of the history loading dependency.