

Multi-analytical characterization of brake dust pre- and post-interaction with simulated biofluid

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Car brakes are a significant source of particulate matter (PM), which can be internalized in different organs and pose risks to human health. Some of these particles are primarily composed of Fe and other heavy metals elements having the potential to interact with the human brain, as well as other tissues and organs, potentially leading to detrimental effects.

As the automotive industry transitions to hybrid and electric vehicles, it is essential to assess whether these newer vehicles generate a different quantity and variety of particles compared to combustion vehicles, and how these particles may interact with the human body.

In this study we characterized the brake dust produced by different types of cars, such as combustion and hybrid, by PXRD, SEM-EDXS, S/TEM-EDXS and Dual-range EELS.

A dissolution test, combined with ICP-MS analysis, was also conducted to evaluate the release of Fe ions in an environment simulating generic body fluids.

The results of this study provided a detailed morphological and dimensional characterization of the brake dust, in particular, most of the particles were present as aggregates made up of round particles, elongated particles, or a mix of the two morphologies with irregular features, and the main metal element found in the samples was Fe.

After the interaction with the simulated biofluid, the aggregate structure was not compromised, since we did not observe evidence suggesting the detachment of single particles, and Fe was still the metal element with higher concentration and occurrence. Dual-range EELS analysis revealed a general trend of Fe oxidation, highlighting a possible link with reactive oxygen species generation and related targets.

These findings offer valuable insights into the understanding of the interactions and mechanisms that stand behind the health risk posed by automotive brake dust, contributing to the broader understanding of the neurotoxic potential of PM. The study also highlights the importance of tracking and quantifying non-exhaust emissions, which constitute a significant portion of urban pollution, in environmental regulations.

This work supports the development of improved legislations to address the release of inorganic PM, including heavy metals and ferromagnetic particles, from vehicle emissions.