Comparison of Brake Wear Dust and Reference Diesel Particulate Matter Pro-Inflammatory Responses in Human THP-1 Macrophage-Like Cells

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Introduction

- With increasingly strict tailpipe emission regulations, the relative contribution from non-tailpipe emissions, in particular brake wear dust, to urban particulate matter (PM) has become more significant
- Brake wear dust contributes as much as 55% to non-tailpipe emission and as much as 21% to traffic related PM
- Studies considering the effect of brake wear dust on cellular responses are limited
- Brake wear dust is rich in metals in contrast to the carbonaceous-rich tailpipe emissions

Approach

Exposure of human THP-1 macrophage-like cells to brake wear dust and reference diesel particulate matter in-vitro using air liquid interface sampler (CelTox sampler)

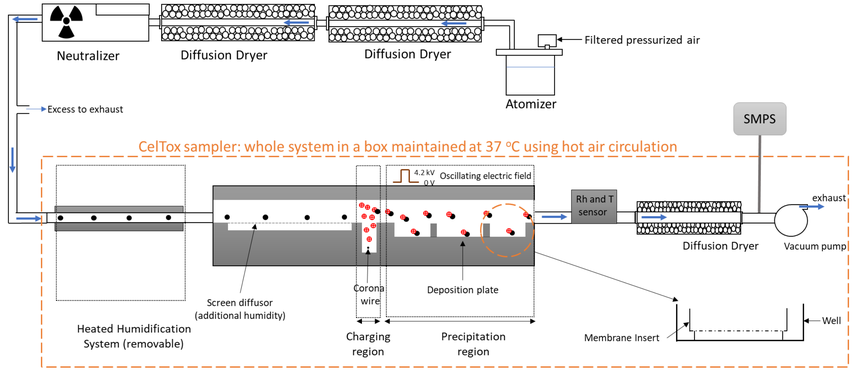
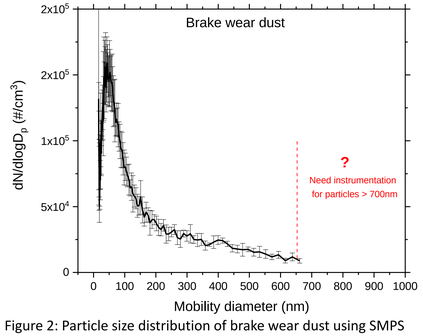
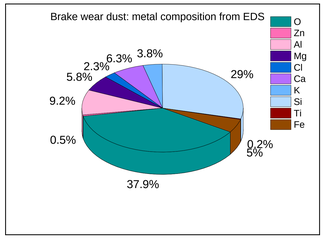


Figure 1: Simple schematic of electrostatic-based ALI system. Cells are grown on apical side of a membrane insert, placed inside the wells of a six-well plate. The basolateral side contains media to provide nutrition to the cells.

Physical and Chemical Characteristics



Metal-rich brake wear dust



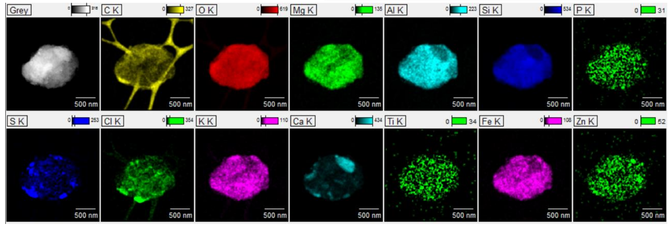
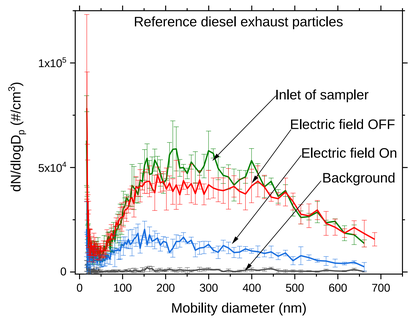
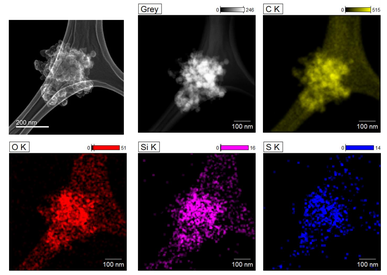


Figure 2: Particle size distribution of brake wear dust using SMPS and metal composition using EDS

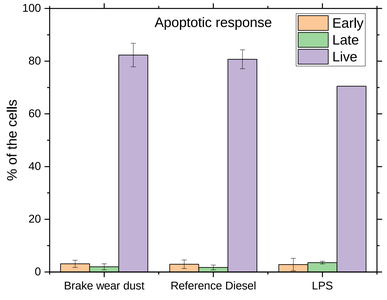




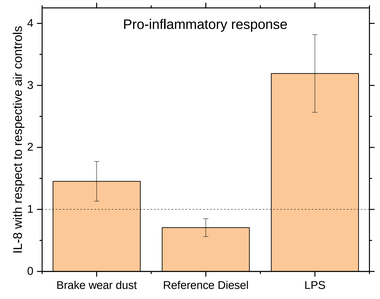
Carbon-rich reference diesel particulate matter

Figure 3: Left: Particle size distribution for reference diesel particles at inlet and outlet (measured with the electric field OFF and electric field ON) of the air-liquid interface sampler. The error bars denote standard deviation (n=4). Right: Morphology and elemental composition of a reference diesel particle using STEM and EDS, respectively.

Cellular response in THP-1: Dose of 2 μg/cm²



- Cell viability of 97%-116% for particles exposures
- Safe dose of 2 ug/cm² → very low early and late apoptosis



- Significantly higher inflammation by brake wear dust at safe dose
- Immunosuppression of inflammatory marker for reference diesel particulate matter exposure

Figure 4: Left: Apoptotic response in differentiated THP-1 cells at a dose of 2 μg/cm² for 24 hr. Error bars denote standard deviation (n=24). Right: IL-8 response from differentiated THP-1 cells to 2 μg/ cm² particles. Error bars denote standard deviation (n=24)

Conclusions

- Exposure to brake wear dust induces pro-inflammation in macrophage-like cells, attributed to the metal-rich composition
- Further study required for better understanding of health effects of brake wear dust

Acknowledgement

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