Secondary particle formation through the oxidation of volatile brake wear emissions

A. Patel[1,2,3], P. Simonen[4], S. Aggarwal[1,2], L. Bard[5], O. Durif[6], M. Huovinen[4], M. Introna[1], A. Teresa Juárez-Facio[1], A. Karppinen[4], M. Tu[5], K. Elihn[1], B. Nozière[6], J. Keskinen[4], U. Olofsson[5], S. S. Steimer[1,2]

[1]Department of Environmental Science, Stockholm University, Stockholm, 114 18, Sweden
[2]Bolin Centre for Climate Research, Stockholm, 114 18, Sweden
[3]now at: Department of Atmospheric and Oceanic Sciences, UCLA, Los Angeles, CA 90095-1565, USA
[4] Department of Physics, Tampere University of Technology, 33101 Tampere, Finland
[5]Department of Machine Design, KTH Royal Institute of Technology, 10044, Stockholm, Sweden
[6]Department of Chemistry, KTH Royal Institute of Technology, 10044, Stockholm, Sweden
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Presenting author email: Sarah.Steimer@aces.su.se

Road traffic is an important source of urban air pollution. Due to increasingly strict controls of exhaust emissions from road traffic, non-exhaust emissions now make up a major proportion of road traffic emissions in many countries (Harrison et al. 2021, Fussell et al. 2022). Brake wear is one of the main non-exhaust sources contributing to the emissions of particulate matter. While the focus of brake wear emission measurements has so far largely been on these primary particulate pollutants, some studies indicate that the braking process can also lead to the emission of gases such as volatile organic compounds. A recent study did for example find compounds such as polyaromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylenes among the emissions from brake wear (Plachá et al. 2017). However, at this point only little is known about the gaseous emissions from braking and their fate in the atmosphere.

In this study, we used an oxidation flow reactor to simulate the oxidative ageing of gaseous brake wear emissions generated with a pin-on-disc tribometer. The results show that photooxidation of gaseous brake wear emissions can lead to the formation of secondary particulate matter (Fig.1).

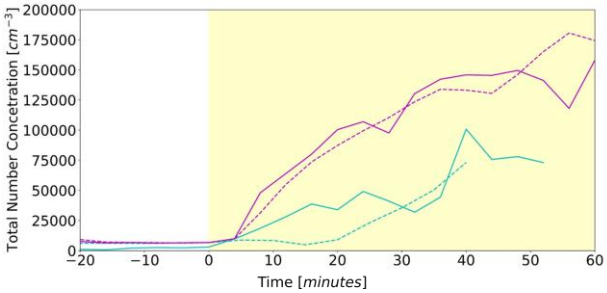

Figure 1. Development of the total number concentration in the oxidation flow reactor over the tribometer running time. Solid cyan and magenta lines represent equivalent ambient ages of 7 days and 9 days respectively, whereas the dashed lines are a repeat for each equivalent age. The period shaded in yellow indicates when the tribometer was running (i.e. wear emissions were generated).

In addition, we used Proton Transfer Reaction - Mass Spectrometry (PTR-MS) and an Aerosol Mass Spectrometer (AMS) to monitor the chemical composition of the gas phase and the particle phase for both fresh and aged emissions. These measurements showed that the chemical composition of both the gas phase and the secondary particles differs for different brake pad materials. However, emission of volatile organic compounds and formation of secondary organic particular matter were observed for all the tested materials.

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