Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

12. International ETH-Conference on

Combustion Generated Nanoparticles

Zürich, 23th - 25th June 2008

ETH Zürich, Prof. Dr. K. Boulouchos
FHNW Brugg-Windisch, Prof. Dr. H. Burtscher

TTM, A. Mayer, Editor
July 2008

Session 4A: Health Effects (1) Chairman: B. Rothen-Rutishauser
● Peters A. / Helmholtz Zentrum München, Germany *Epidemiology on Health Effects of Solid Nanoparticles*
● Riediker M. / Institute for Work and Health, Lausanne, Switzerland *A System to test the Toxicity of Brake Wear Particles from Cars*
● Oravisjärvi K. / University of Oulu, Finland *Deposition of Inhaled Particles from Diesel Fuelled Engines in Human Lungs: Comparison between Men and Women in Different Activity Levels*
● Stoeger T. / Helmholtz Zentrum München, Germany *Relationship between in vivo and in vitro Toxicity of six Types of Carbonaceous Nanoparticles*

Riediker M. / Institute for Work and Health, Lausanne, Switzerland

A system to test the toxicity of brake wear particles

Fine particulate matter from traffic increases mortality and morbidity. An important source of traffic particles is brake wear. American studies reported cars to emit break wear particles at a rate of about 11mg/km to 20mg/km of driven distance. A German study estimated that break wear contributes about 12.5% to 21% of the total traffic particle emissions. The goal of this study was to build a system that allows the study of brake wear particle emissions during different braking behaviours of different car and brake types. The particles should be characterize in terms of size, number, metal, and elemental and organic carbon composition. In addition, the influence of different deceleration schemes on the particle composition and size distribution should be studied. Finally, this system should allow exposing human cell cultures to these particles.

An exposure-box (0.25 cubic-m volume) was built that can be mounted around a car's braking system. This allows exposing cells to fresh brake wear particles. Concentrations of particle numbers, mass and surface, metals, and carbon compounds were quantified. Tests were conducted with A549 lung epithelial cells. Five different cars and two typical braking behaviours (full stop and normal deceleration) were tested.

Particle number and size distribution was analysed for the first six minutes. In this time, two braking events occurred. Full stop produced significantly higher particle concentrations than normal deceleration (average of 23'000 vs. 10'400 #/cm3, p= 0.016). The particle number distribution was bi-modal with one peak at 60 to 100 nm (depending on the tested car and braking behaviour) and a second peak at 200 to 400 nm. Metal concentrations varied depending on the tested car type. Iron (range of 163 to 15'600 µg/m3) and Manganese (range of 0.9 to 135 µg/m3) were present in all samples, while Copper was absent in some samples (<6 to 1220 µg/m3). The overall "fleet" metal ratio was Fe:Cu:Mn = 128:14:1.

Temperature and humidity varied little. A549-cells were successfully exposed in the various experimental settings and retained their viability. Culture supernatant was stored and cell culture samples were fixated to test for inflammatory response. Analysis of these samples is ongoing.

The established system allowed testing brake wear particle emissions from real-world cars. The large variability of chemical composition and emitted amounts of brake wear particles between car models seems to be related to differences between brake pad compositions of different producers. Initial results suggest that the conditions inside the exposure box allow exposing human lung epithelial cells to freshly produced brake wear particles.

Tel. +41(21)314 74 53
Michael.riediker@hospvd.ch