# ROS production of source-specific emissions from combustion, brake, tire and road wear

V. Malmborg[1,5], Sara Bengtsdotter[1], M. Gustafsson[2], J. Wahlström[3], K.R. Dällenbach[4], J. Pagels[1], Y. Lyu[3], U. Vogel[5]

[1]Ergonomics and Aerosol Technology, LTH, Lund University, Lund, Sweden
[2]Swedish National Road and Transport Research Institute (VTI), Linköping, Sweden
[3]Machine Elements, LTH, Lund University, Lund, Sweden
[4]Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen, Switzerland
[5]The National Research Centre for the Working Environment, Copenhagen, Denmark

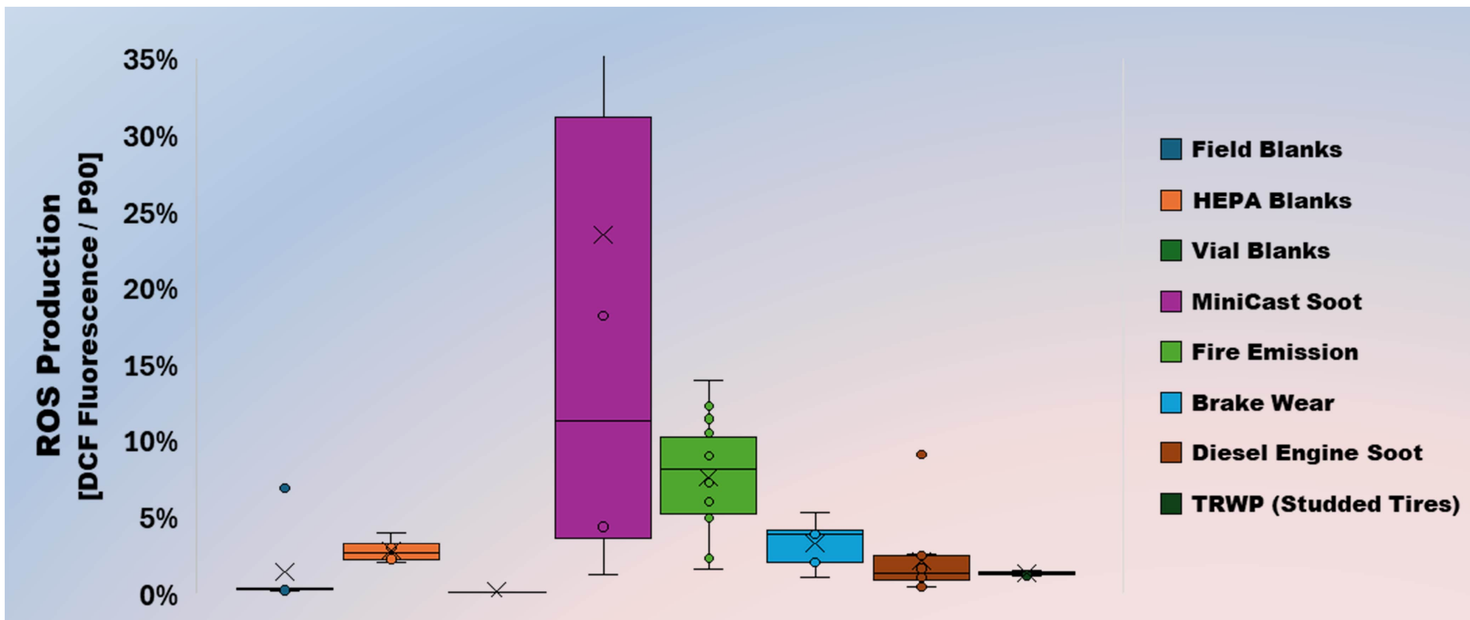


Figure 1. ROS production results of multiple conditions for each source category (acellular $DCFH_2$-DA assay).

Soot > Fire Emissions > Brake Wear > Diesel Engine > Road Wear


Figure 2. Road Simulator at VTI (Linköping, Sweden).

## Highlights

- Aim: To improve our understanding of the source-specific contributions to ambient air particle toxicity.
- How? By quantification and comparison of the acellular Reactive Oxygen Species (ROS) production and Oxidative Potential (OP) of individual particle components from key traffic-related and urban combustion sources.
- Societal Relevance: The project can inform new health policies and emissions legislation by providing a basis for targeting the most harmful components.

## ROS Production

- Source-specific ROS production (Figure 1): PM from traffic-related and urban combustion sources (brake, tire, road wear, diesel engine, and fires) differ significantly in ROS production. All sources had lower ROS production (1-70%) compared to the positive control (Printex 90).
- Non-exhaust emissions: Brake wear had similar or higher ROS production to diesel exhaust, while tire and road wear emissions showed very low response.
- Soot: Black Carbon exhibited higher ROS production than soot with Brown Carbon characteristics and fire smoke with high organic contribution to the PM composition.

## Future Work

- Road Surface Emissions: Developing screening methods for road dust (excluding tire particles) from various pavement materials (Figure 5).
- Surface Area: Particle morphology and specific surface area may help explain differences in ROS production.
- Grouping by similarity: Developing criteria for grouping by physical and chemical characteristics.
- Toxicity evaluation: Acellular OP measurements (DTT, AA assays), *in vitro cell* and *in vivo* toxicological analyses on selected samples.

## Particle Generation

- Tire/Road Wear: Advanced road simulator with summer, winter-friction, and studded winter tires on cement concrete pavement - no bitumen and low contribution of tire-wear particles (Figure 2).
- Combustion: MiniCAST soot generator, heavy-duty diesel engine (renewable/fossil diesel), real-scale simulated arson compartment fires (Figure 3).
- Brake Emissions: Pin-on-disc tribometer using EU and USA relevant pin materials on a grey-cast iron disc (Figure 4).

## Limitations

- Uncertainty: ROS production at or close to filtered-air background control levels induces uncertainty in the assessment of ROS production and the comparison between sources.

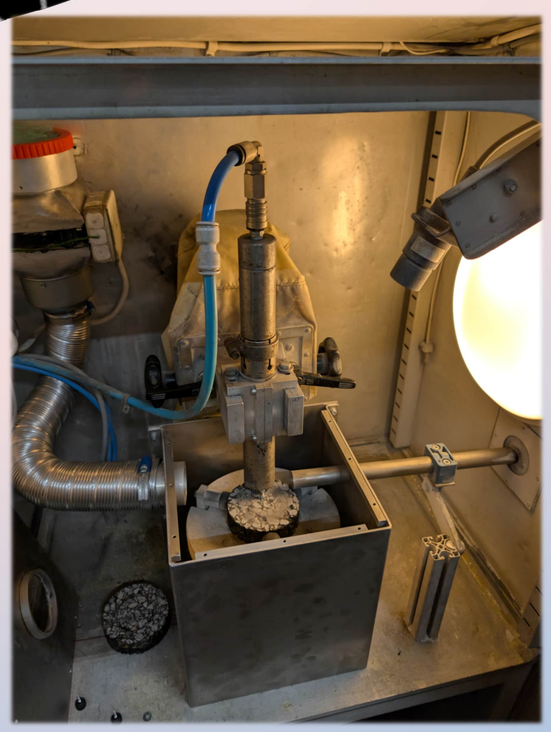

Figure 5. Tröger Road Wear screening method at VTI (Linköping, Sweden).


Figure 3. Combustion emission sources.

Figure 4. Pin-On-Disc Brake Wear method.

KOMPETENSCENTRUM VÄGTEKNIK
FORMAS
Vetenskapsrådet
Swedish Research Council

Vilhelm Malmborg | Design Sciences, LTH | IKDC, Formstråket 13, Lund, Sweden | vilhelm.malmborg@design.lth.se