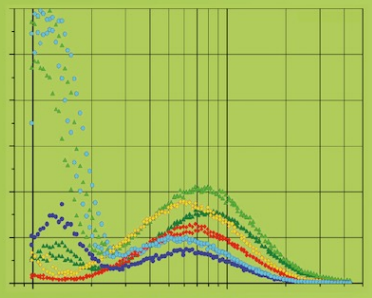

25th ETH-Conference on Combustion Generated Nanoparticles

June 21-23, 2022, online conference

Conference Program

Abstacts of the Contributed Lectures of the topical sessions

Abstracts of the lectures of the Focus Event

Virtual Poster Abstracts (incl. Short Talks)

npc22.scg.ch

ETH zürich

SCS Swiss Chemical Society

25th ETH-Conference on Combustion Generated Nanoparticles

June 21-23, 2022, online copnference

Corona viruses have turned into persistent threats for our society. Once again, we have decided to organize the 25thETH-Conference on Combustion Generated Nanoparticles as an online event under the auspice of the Swiss Chemical Society. It served as an interdisciplinary platform for expert discussions on all aspects of nanoparticles, freshly emitted from various sources, aged in ambient air, technical mitigation aspects, impact of particles on health, environment and climate and particle legislation. The conference brought together representatives from research, industry and legislation.

Conference Topics

- Ambient air particles, secondary pollutants
- Aircraft, marine and non-Road sources
- Biomass-, biofuel and synfuel combustion
- Brake- and tyre-wear, non-combustion emissions
- Emission control of combustion engines
- Emission upgrade and PTI for in-use vehicles
- Environmental and health effects
- Exhaust aftertreatment systems
- Future legislation and enforcement
- Impact on climate
- Nanoparticle metrology and chemical characterization
- Nanoparticle chemistry and toxicology
- Occupational exposure and prevention

Focus Event: New Legislation to Guide the World

The World Health Organization air quality guidelines, European vehicle and engine legislation, national clean air acts, and periodic technical inspection (PTI) legislation have become key elements of international and national clean air policy. With no doubt, the implementation of catalytic converter technologies and better fuels, compatible with such technologies, were major steps to reduce emission of combustion enginges.
The 2022 focus event will discuss the next legislative steps to take and the challenges to tackle with new fuels and new enginge and vehicle technologies, to further reduce the impact of air pollution on health and global warming.

Health Session

The health session will focus on the effects of aircraft-/airport and wood smoke/wildfire related emissions.

Program Tue, June 21, 2022

Back to Program Overview

All indicated times are in CEST (GMT +2). Convert CEST into any time zome.

10.00 Welcome, Introduction and Conference Opening
Norbert Heeb, Empa

10.10 Welcome Address from Swiss Federal Office of Energy
Stephan Renz, Carina Alles

Session 1: Ambient air particles
Chairs: Martin Gysel, Norbert Heeb

10.20 ***Joel Corbin***, National Research Council Canada
«Mechanisms of soot aggregate restructuring and compaction»

10.40 ***Georgios Kelesidis***, ETH Zürich
«Enhanced light absorption and radiative forcing by black carbon agglomerates»

11.00 ***Anurag Chaudhary***, Junoterra Technology Private Limited, New Delhi , India
«Comparative assessment of indoor and outdoor air quality at a semi-urban site in Delhi for observing seasonal variations and potential health effects»

11.20 ***Hiroyuki Hagino***, Japan Automobile Research Institute
«Environmental temperature effects on secondary organic and inorganic aerosols formed from vehicle exhausts»

11.30 ***Samridhi Dwivedi***, Isabella Thoburn College
«Assessment of Sub-Micron Particulate Matter and associated Poly aromatic hydrocarbons in indoor and outdoor air of Lucknow city: Capital of the most populated state of India»

12.00 Lunch Break

Session 2: Aftertreatment
Chairs: Christophe Barro, Martin Stöckli

13.00 ***Seongho Jeong***, Helmholtz Zentrum München/University of Rostock
«Evaluation of aerosol emission from a marine diesel engine using a wet sulfur scrubber and filtration system for exhaust gas abatement»

13.20 ***Kazuhiro Yamamoto***, Nagoya University
«Numerical simulation of SiC sponge potentially applied for gasoline particulate filter»

13.40 ***Serap Karahanogullari***, RWTH Aachen University
«The effects of three-way catalyst samples on particulate emissions from a spark ignited single cylinder engine»

13.50 ***Tawfiq Al-Wasif***, CIEMAT
«Experimental study on nanoparticles emissions from a TSI E6 vehicle beyond the boundary altitude conditions of the RDE»

14.00 ***Anastasios Kontses***, Aristotle University of Thessaloniki
«Urban and Cold-Start Phase Particle Emissions of a Gasoline Hybrid and a CNG Vehicle»

14.10 ***Janis Beimdiek***, Paderborn University
«Novel entrained flow SCR using online synthesized catalyst particles in flue gas cleaning systems»

14.20 ***Daniel Wohter***, RWTH Aachen University
«Reduction of PAHs by the Use of Electrostatic Precipitators at Different Positions in the Exhaust Gas Stream of Logwood Stoves»

14.30 Break

Session 3: Emission Control
Chairs: Martin Stöckli, Christophe Barro

14.45 ***Christophe Barro***, Vir2sense
«Virtual Sensor for Soot Emissions in Heavy Duty Diesel Engines using alternative Fuels»

15.05 ***David B. Kittelson***, University of Minnesota
«Effective Density and IPSD Measurements of solid PM from a Lean and Stoichiometric GDI Engine Operating on Ethanol Blends»

15.25 ***Akshat Jain***, Indian Institute of Technology Goa
«Enhancement in Performance Parameters and Reduction in Exhaust Emissions of a Compression Ignition Engine using Stable Nanofuel Suspension»

15.35 ***Héctor García González***, Instituto Nacional de Silicosis
«Systems for the reduction of Combustion Generated Nanoparticles in Heavy Plant Machinery»

15.45 Break

Session 4: Brake- and tyre-wear, non-combustion emissions
Chairs: Danilo Engelmann, Claus-Detlef Schegk

16.00 ***Linda Bondorf***, German Aerospace Center (DLR)
«Measurement of brake and tyre wear emissions from a battery electric vehicle»

16.20 ***Heejung Jung***, University of California, Riverside
«Real-World Brake and Tire Wear PM Emissions Near Californian Highways»

16.40 ***Maryam Zare Shahne***, Khaje-Nasir-Toosi university of Technology
«Determining the contribution of non-combustion sources by the fine PM source apportionment results in Tehran, Iran»

16.50 ***Martin Tanner***, TOFWERK AG
«Inductuvely Coupled Nitrogen Plasma Mass Spectrometry for online monitoring of metals in airborne particles»

17.00 End of Day 1

Program Wed, June 22, 2022

Back to Program Overview

All indicated times are in CEST (GMT +2). Convert CEST into any time zome.

Session 5: Nanoparticle metrology A
Chairs: Konstantina Vasilatou, Oliver Bischof

10.00 ***Martin Fierz***, naneos particle solutions
«A new device for fast solid-volatile nanoparticle differentiation»

10.20 ***Martin Irwin***, Catalytic Instruments
«Characterising the Silver Particle Generator: a pathway towards standardising aerosol generation»

10.40 ***Alejandro Keller,*** FHNW
«The organic coating unit, an all-in-one system for reproducible generation of secondary organic aerosol»

11.00 ***Una Trivanovic***, ETH Zürich
«High-throughput generation of aircraft-like soot»

11.10 ***Sonia Lara Gomez***, Castilla La Mancha University
«Accurate quantification of Polycyclic Aromatic Compounds (PACs) adsorbed on soot samples»

Exhibitor Session
Chair: Heinz Burtscher, FHNW/ISE

11.20 ***Jürgen Spielvogel***, TSI GmbH
«Airborne Particle Measurement Used in Brake Wear Emission Research, Occupational Exposure Assessments and Numerous Other Applications»

11.35 ***Markus Nikka***, Dekati Ltd.
«Dekati® ePNC™ - A Novel Technology for Regulatory PTI Particle Number Measurements»

11.50 Mettler Toledo GmbH
«METTLER TOLEDO's Filter Weighing Solutions – Main Product Highlights»

12.00 Lunch Break

Session 6: Nanoparticle metrology B
Chairs: Oliver Bischof, Konstantina Vasilatou

13.00 ***Griša Močnik***, University of Nova Gorica
«A dual-wavelength photothermal aerosol absorption monitor: design, calibration and measurements of absorption enhancement due to coating»

13.20 ***Evangelos Stefanidis***, University of Connecticut
«*In-situ* Characterization of Catalyst Nanoparticles from Reactive Spray Deposition Technology (RSDT)»

13.40 ***María Aranda***, Universidad de Castilla-La Mancha
«Soybean/palm biodiesel soot: characterization and heterogeneous reactivity with NO2 and CF3COOH»

13.50 ***Jason Scott***, Carleton University
«Flame Spray Pyrolysis to Asses Sustainable Aviation Fuel Emissions»

14.00 Break

Session 7: Health effects A: aircraft
Chairs: Nino Künzli, Barbara Rothen

14.15 ***Ulla Vogel***, National Research Centre for the Working Environment
«Airport emission particles: exposure characterization and toxicity following intratracheal instillation in mice»

14.35 ***Mathilde Delaval***, Helmholtz Munich
«Respiratory health effects of aircraft emissions: an in vitro study for evaluating the toxicity of non-volatile particulate matter from an aircraft turbofan engine on bronchial epithelial cells»

14.55 ***Anna Wu***, University of Southern California
«Airport-related ultrafine particles and risk of malignant brain cancer among Los Angeles participants in the Multiethnic Cohort Study»

15.15 Break

Session 8: Health effects B: viruses and wood combustion
Chairs: Loretta Müller, Ron Kappeler

15.30 ***Meghan Rebuli***, University of North Carolina at Chapel Hill
«Impact of combustion-generated particles on respiratory response to viral infection»

15.50 ***Verena Haefner,*** Helmholtz Zentrum München
«Nanoparticle-Triggered Reactivation of Latent Virus Infection – A Link between the Inflammatory Response to Air Pollutants and Chronic Lung Disease»

16.10 ***Lianyong Han***, Helmholtz Zentrum München
«Environmental nanoparticle exposure triggers gammaherpesvirus reactivation via the MAPK signaling pathway in macrophages»

16.20 ***Uschi Graham***, University of Kentucky
«Inhalation Exposure to Wildfire and Burn Pit Smoke: A Common Etiology for Neurogenic and Oncogenic Diseases of the Brain Involving Iron?»

16.40 ***Arya Mukherjee***, University Of Eastern Finland, Kuopio, FI-70211, Finland
«Particle effective densities and size distributions in vehicular and wood combustion exhaust emissions: Implications to particle deposition in the human respiratory system»

16.50 ***Manuel Garcia-Käufer***, University Hospital Center Freiburg
«Health Impact Assessment of inhaled log wood stove emissions by means of novel in-vitro exposure devices based on the air-liquid interface technique to evaluate the efficiency of technical emission reduction measures on the biological effect level»

17.00 End of Day 2

Program Thu, June 23, 2022

Back to Program Overview

All indicated times are in CEST (GMT +2). Convert CEST into any time zome.

Session 9: Occupational and indoor exposure, fundamentals and future legislation
Chairs: Christoph Hüglin, Norbert Heeb

10.00 ***Heinz Burtscher,*** FHNW/ISE
Andreas Mayer, NanoCleanAir
«Indoor Protection from Viruses and Combustion Generated Nanoparticles»

10.20 ***Stig Koust***, Danish Technological Institute
«Evaluating clean air technologies for mobile air purifiers»

10.40 ***Kaare Press-Kristensen***, Green Transition Denmark
«The efficiency of mobile air purifiers in private homes»

10.50 ***Shobhana Ramteke***, Integrated Regional Office, Ministry of Environment, Forest and Climate Change
«Distribution Size Segregation, Sources of Indoor Particulate Matter during burning of Mosquito Coils and Incense Sticks Emissions and their Health Impacts»

11.00 ***Klaudia Köbölová***, Brno University of Technology
«Influence of the combustion phase on the physico-chemical properties of particulate matter»

11.10 ***Farnaz Khosravi***, University of Connecticut
«Controlling the Sampling Parameters to quench Collision Growth of Soot Particles extracted from Laminar Premixed Flames»

11.20 ***Yadvendra Ahlawat***, The NorthCap University Gurugram, India
«A critical evaluation of failures in current air pollution control policies in India and proposal of innovative future policy perspectives»

11.30 Award Ceremony
Oliver Bischof

12.00 Lunch Break

Session 10: Health effects C: toxicology
Chairs: Loretta Müller, Nino Künzli

13.00 ***Anusmita Das***, Helmholtz Munich
«Generation and characterization of ultrafine soot particles with similar physical but varying chemical properties enabling differential toxicological assessment in human lung cells»

13.20 ***Maurizio Gualtieri,*** University of Milano-Bicocca
«On the toxicological effects of primary vs secondary aerosols: implication for human health»

13.30 ***Anna von Mikecz***, IUF — Leibniz Research Institute of Environmental Medicine, Duesseldorf, Germany
«From roadside to lab with elegant roundworms»

13.50 ***Inge Scharpf***, IUF – Leibniz Research Institute of Environmental Medicine
«Effects of Traffic-Related Nanoparticles in the animal model C. elegans: Neurodegeneration and Neurodegenerative Diseases»

Focus Event: New legislation to guide the world

Part 1: New ambient air legislation
Chairs: Andreas Mayer, Norbert Heeb

14.00 ***Andreas Mayer,*** TTM
«How to guide legislation - An introduction to the ETH-NPC focus event»

14.20 ***Nino Künzli,*** Swiss TPH, University of Basel
«Role of the new WHO Air Quality Guidelines»

14.40 ***Christoph Hüglin***, Empa
«On the effects of past and future ambient air regulations on air quality in Switzerland»

15.00 Break

Part 2: New vehicle legislation and inspection
Chairs: Andreas Mayer, Norbert Heeb

15.20 ***Pascal Buerkenhoudt***, CITA, International Motor Vehicle Inspection Committee
«Cleaner air due to vehicle approval or vehicle inspection?»

15.40 ***Norbert Heeb***, Empa
«New legislation to guide the world: Where are we now and in which direction should we go?»

Part 3: Panel Discussion
Moderators: Loretta Müller, Oliver Bischof

16.00 Panel Discussion

16.50 Closing Words and Goodbye
Loretta Müller

17.00 End of the Conference

Enhanced light absorption and radiative forcing by black carbon agglomerates

G. A. Kelesidis[1], D. Neubauer[2], L. Fan[3], U. Lohmann[2], S. E. Pratsinis[1]

[1]Particle Technology Laboratory, Department of Mechanical and Process Engineering, ETH Zürich, [2]Institute of Atmospheric and Climate Science, Department of Environmental Systems Science, ETH Zürich, [3]Department of Chemical and Biomolecular Engineering, The Ohio State University

The climate models of the Intergovernmental Panel on Climate Change (IPCC) list black carbon (BC) as an important contributor to global warming based on its radiative forcing (*RF*) impact. Examining closely these models, it becomes apparent that they might underpredict significantly the direct *RF* for BC, largely due to their assumed spherical BC morphology [1]. In specific, the light absorption and direct *RF* of BC agglomerates are enhanced by light scattering between their constituent primary particles [2] as determined by the Rayleigh-Debye-Gans theory interfaced with discrete dipole approximation [3] and recent relations for the refractive index and lensing effect. The resulting light absorption agrees very well with the observed absorption aerosol optical depth of BC. ECHAM-HAM simulations accounting for the realistic BC morphology and its coatings reveal high direct *RF* = 3 - 5 W/m^2 in East, South Asia, sub-Sahara, western Africa and the Arabian peninsula (Fig. 1). These are in agreement with satellite and AERONET observations of *RF* and indicate a regional climate warming contribution by 0.75 - 1.25 ^{o}C, solely due to BC emissions.

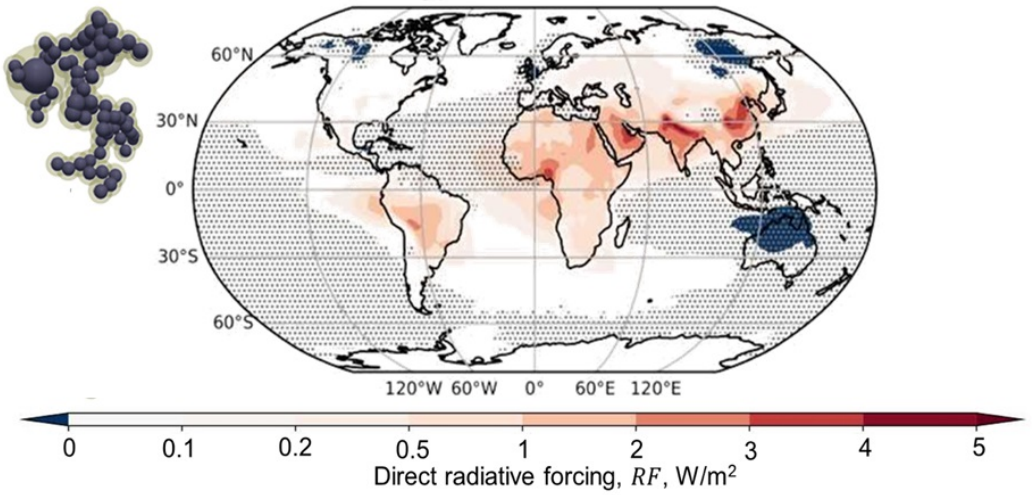

Figure 1. Global map of the direct *RF* of coated BC agglomerates estimated by ECHAM-HAM.

[1] Georgios A. Kelesidis, Sotiris E. Pratsinis, *Proceedings of the Combustion Institute,* **2021,** 38, 1189-1196, doi.org/10.1016/j.proci.2020.07.055.
[2] Georgios A. Kelesidis, M. Reza Kholghy, Joel Zuercher, Julian Robertz, Martin Allemann, Aleksandar Duric, Sotiris E. Pratsinis, *Powder Technology,* **2020,** 365, 52–59, doi.org/10.1016/j.powtec.2019.02.003.
[3] Georgios A. Kelesidis, Sotiris E. Pratsinis, *Proceedings of the Combustion Institute,* **2019,** 37, 1177-1184, doi.org/10.1016/j.proci.2018.08.025.

Comparative assessment of indoor and outdoor air quality at a semi-urban site in Delhi for observing seasonal variations and potential health effects

A. S. CHAUDHARY[1], A. BHARDAWAJ[3]*, R. BHARDWAJ[1,2]

[1]Junoterra Technology Private Limited, New Delhi , India, [2]Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur, India, [3]Junoterra Technology Private Limited, New Delhi, India

Air pollution is one of the leading causes of morbidity and mortality globally [1, 2]. Delhi is consistently ranked among the top air polluted cities of the world [3]. This paper is intended for a comparative assessment of indoor and outdoor air quality at Anand Vihar, Delhi; which is a semi urban site located at 28.6502° N, 77.3027° E. The methodology involved the collection of outdoor air quality data from central pollution control board's (CPCB) stationary monitoring unit at Anand Vihar from 1st January 2021 to 31st December 2021 covering all four major seasons namely winter, spring, summer and monsoon. Concurrently, for the same duration, the indoor air quality data at a residential house nearby was obtained using AirCubic indoor air quality sensor model T1595 for the same time duration. The parameters studied were particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), temperature and relative humidity (RH). The data so obtained were statistically analysed. The major results obtained were that the variation in outdoor and indoor air quality parameters varied more during winters than other seasons. There was a decrease in values of PM and RH indoors than outdoors whereas CO levels were more indoors than outdoors. But in most cases, the values obtained were above permissible limits as per international standards which may lead to chronic and acute negative health effects, morbidity and mortality; if the exposure is for a long duration of time. Hence it may be concluded that there is an urgent need for installing a huge web of stationary and mobile air quality monitoring stations for observing outdoor air quality and compact sensor-based air quality monitoring devices for examining indoor air quality. It is expected that this research will help motivate the policy makers, government officials and public in general to install more indoor air quality sensors as a necessary health monitoring equipment and increase the number of outdoor monitoring stations to help the residents in planning their daily activities as per the prevailing indoor and outdoor air quality to reduce the exposure to pollutants and lead a healthy life.

[1] Bhardawaj A, Habib G, Kumar A, Singh S, Nema AK. A review of ultrafine particle-related pollution during vehicular motion, health effects and control. *J. Environ. Sci. Public Health.* **2017**;1(04):268-88.

[2] Bhardawaj A, Habib G, Singh S. Ambient aerosol induced cardiovascular disease among subjects in monsoon and winter season. In *AAAS Annual Meeting, Boston* **2017** Feb 16.

[3] Bhardawaj A, Habib G, Padhi A, Anand A, Mahala N, Singh BK. Deteriorating air quality and increased health risks in Delhi: The decisions being delayed*. IIOAB Journal.* **2016**;7:10-5.

Mechanisms of soot aggregate restructuring and compaction

J. C. Corbin[1], R. Modini[2], M. Gysel-Beer[2]*

[1]National Research Council Canada, [2]Laboratory of Atmospheric Chemistry, PSI Switzerland

Soot aggregates form as open, fractal-like structures, but aged atmospheric particles are often observed to be restructured into more compact shapes. This compaction has a major effect on the radiative properties of the aggregates, and may also influence their aerosol-cloud interactions and toxicity. Recent laboratory studies have presented conflicting arguments on whether this compaction occurs during condensation or during evaporation. In this three-part study, we combine theory and experiments to explain these conflicting results. First, we review the surface-science literature and identify explicit mechanisms condensation compaction as well as evaporation compaction. We also identify a mechanism for avoiding compacting during condensation, which is predicted from heterogeneous nucleation theory and the kinetic barriers to capillary formation. Second, we review the soot-restructuring literature and find evidence for all of these compaction mechanisms, the most common being condensation-compaction. Some atmospheric studies have reported non-compacted soot in internal mixtures, which we attribute to coagulation, and which is less common. Third, we present new experimental results from a study in our laboratory where the surface tension of anthracene coatings was switched on or switched off by using solid or liquid phases during addition and removal. Consequently, we demonstrated condensation compaction, evaporation compaction, and no compaction, for the same soot source. Overall, our study indicates that it is most reasonable to assume that soot will undergo compaction upon coating condensation in the atmosphere, in combustion systems, and in human lungs.

Evaluation of aerosol emission from a marine diesel engine using a wet sulfur scrubber and filtration system for exhaust gas abatement

S. Jeong[1,4], J. Bendl[2], M. Saraji-Bozorgzad[2], U. Käfer[1,4], U. Etzien[3], J. Schade[2,4], T. Streibel[1,4], J. Schnelle-Kreis[1,4], M. Sklorz[1,4], T. Adam[1,2]*, R. Zimmermann[1,4]*

[1]Joint Mass Spectrometry Center (JMSC) at Comprehensive Molecular Analytics (CMA), Department Environmental Health, Helmholtz Munich, Ingolstädter Landstr. 1, 85764 Neuherberg, Germany, [2] University of the Bundeswehr Munich, Faculty for Mechanical Engineering, Institute of Chemical and Environmental Engineering, 85577, Neubiberg, Germany, [3]Chair of Piston Machines and Internal Combustion Engines, Faculty of Mechanical Engineering and Marine Technology, University of Rostock, Albert-Einstein-Strasse 2, 18059, Rostock, Germany, [4]Joint Mass Spectrometry Center (JMSC) at Chair of Analytical Chemistry, Institute of Chemistry, University of Rostock, Albert-Einstein-Strasse 27, 18059 Rostock, Germany

Introduction: Due to the lack of tight regulations regarding ship emissions and their deposition, the maritime transport logistics become one of the main contributors to air pollution. Among various ship emission pollutants, the direct and indirect effects caused by SO_x emission have gained attention due to their impact on human health and climate change. In order to reduce their environmental burden and potential effects on human health, the International Maritime Organization (IMO) capped the fuel sulfur content (FSC) of marine fuels up to 0.5 % m/m globally and 0.1 % m/m in sulfur emission control areas (SECAs). To comply with the regulations, the conventional low-grade heavy fuel oils have been exchanged with high-quality distillate fuels or low sulfur heavy fuel oils. Alternatively, conventional low-grade heavy fuel oil can be further used in combination with an abatement system such as a sulfur scrubber to reduce the SO_x emissions in the exhaust gas. While numerous studies have exhibited a remarkable reduction of SO_x emission by a scrubber, its removal efficiency regarding particulate matters varies depending on several conditions and remains unclear [1] [2].

Methods & Results: Fine particulate matter ($PM_{2.5}$) emitted from the combustion of three marine fuels, namely marine gas oil (MGO, S < 0.1 % m/m), high-aromatic heavy fuel oil (HFO, S = 1.3 % m/m) and high-sulfur HFO (S = 2.4 % m/m), were investigated at a research ship diesel engine. The change of physical as well as chemical properties of the particles was evaluated by installing a wet scrubber system for exhaust gas cleaning. In addition, further reductions of the particle number and mass concentration by using an additional abatement system, a wet-electrostatic precipitator (WESP), were investigated. Exhaust emissions were analyzed by using on-line techniques for SO_2 and NO_x analysis (FTIR) as well as particles regarding size distribution and mass concentration (SMPS, TEOM, Aethalometer). Filter samples were taken for organic (OC) and elemental carbon (EC) measurements as well as ion-chromatography studies, which demonstrated the mass concentration of sulfur-containing particles as sulfate.

The particle emission of HFOs was distinguished by remarkably higher particle number and mass concentrations as well as left-skewed size distributions compared to MGO. The increased sulfur content of the fuels resulted in higher sulfur-containing particle mass concentration and in higher SO_2 concentration in the raw gas. After the scrubber, the size distribution of HFOs was shifted to larger particles, while the MGO size distribution was almost unchanged. The particle number concentration of all fuel types was reduced by the scrubber up to 40 %. Moreover, a reduction of equivalent mass concentration of black carbon (eBC) and elemental carbon (EC) was observed, whereas the sulfate mass concentration of HFOs was increased after the scrubber. Combining the scrubber with a WESP showed a remarkable reduction of both particle number and mass concentration.

This study is a part of the project SAARUS (03SX483Z, www.saarus.de) supported by Federal Ministry for Economic Affairs and Energy (Germany), the EU-project *ULTRHAS* (European Union's Horizon 2020-955390), dtec.bw-Digitalization and Technology Research Center of the Bundeswehr (project „*LUKAS*“ and „*MORE*“) as well as the Helmholtz International Laboratory *aeroHEALTH* (Interdoke 2025 www.aerohealth.eu)

Numerical simulation of SiC sponge potentially applied for gasoline particulate filter

K. Yamamoto[1], M. Hirota[1], Y. Inui[1]

[1]Nagoya University

In 2019, the 25th Conference of the Parties (COP25) to the United Nations Framework Convention on Climate Change was held in Madrid, Spain. The Paris Agreement has been confirmed, in which an international rule to combat global warming sets a goal to keep the global average temperature rise low enough. Due to their fuel economy, gasoline direct injection (GDI) vehicles are expanding their share of the market. However, different from traditional port fuel injection (PFI) gasoline vehicles, GDI engines emit more particulate matters (PMs). By considering that the stringent regulation is setting in the world for gasoline vehicles, a PM filter for gasoline soot is needed, called a gasoline particulate filter (GPF). So far, we have been focused on SiC sponges potentially applied for GPF, and have tested the soot filtration performance experimentally. It should be noted that SiC sponge has high thermal durability and low porosity with over 80 %. In this study, we simulated the flow with soot deposition by a lattice Boltzmann method (LBM). As seen in Fig. 1, filter substrate with 3D pores in the SiC sponge was obtained by an X-ray CT technique, so that the real flow field was numerically obtained [1,2]. In the simulation, the complex flow pattern is seen in the relatively large pore of the 100 mm. Figure 2 shows the soot deposition region during the depth filtration and the surface filtration. In the presentation, we discussed the effects of the filtration velocity and the soot size on the pressure drop during the filtration.

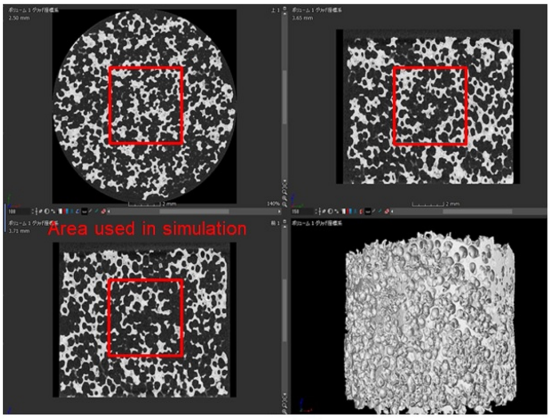

Fig.1 3D pores in SiC sponge by Xray-CT technique.

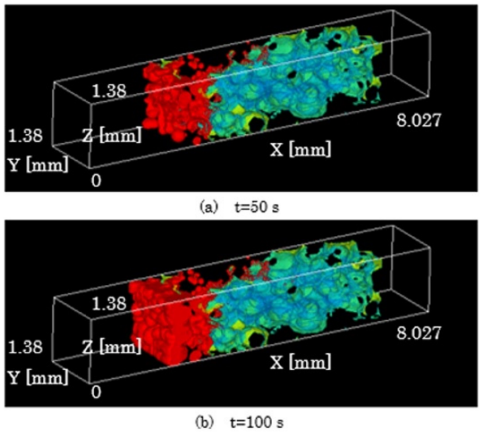

Fig.2 Simulated soot deposition region.

[1] K. Yamamoto, S. Matsumoto, Evaluation of pressure drop during filtration of gasoline particulate filter, Contributed lecture presented at the 23rd ETH-Conference on Combustion Generated Nanoparticles, Zurich, CH, **2019**.

[2] K. Yamamoto, R. Komiyama, T. Sakai, Flow and pressure variations through porous filter during soot filtration and regeneration, ASME Journal of Thermal Science and Engineering Applications, Vol.11, **2019**.

Virtual Sensor for Soot Emissions in Heavy Duty Diesel Engines using alternative Fuels

C. Barro[1,2], P. Kyrtatos[1]

[1]Vir2sense (Baar, Switzerland), [2]Barro@vir2sense.com

The reduction of CO_2 emissions in transport and power generation is a key challenge of the current generation. One particular opportunity of CO_2 reduction is the introduction of fuels with a smaller CO_2 footprint. The combustion characteristics of such fuels are different and require engine settings modification to profit most from these characteristics. The aim of this work is to develop combustion and emission models for a simulation platform for optimizing the overall engine unit (engine with exhaust gas aftertreatment) of vehicles of all sizes for fuels with different characteristics [1]. Therefore, different diesel like fuels have been tested in a single cylinder research engine to determine their detailed behaviour with respect to combustion and emission characteristics. The fuels tested include Hydrotreated Vegetable Oil (HVO), Gas-to-Liquid fuel (GTL) from a Fischer-Tropsch conversion and polyoximethylene dimethylether (OME3-6), which were tested neat and as blends with Diesel or among each other. The combustion analysis showed that changes in fuel composition affect mostly the ignition delay as well as the characteristic mixing rate of the diffusion combustion.

A heat release rate (HRR) model and subsequent emission models for NOx and soot were developed and their model parameters calibrated for standard diesel.

The observed changes in combustion behaviour were used to change the HRR model parameters, resulting in an accurate depiction of the measured HRR for varying fuel composition. The NOx emission model showed very good predictive capability for all fuels with constant parameters, indicating that any change in NOx emissions between the fuels are mostly due to combustion phasing which is captured by the HRR model. The soot model parameters were shown to be affected by fuel composition, with reducing aromatic content and increasing oxygenate content affecting soot production and oxidation respectively. The resulting soot model shows very accurate estimation of emissions for a very wide range of conditions and for all fuels.

[1] Barro et al. , Platform to reduce fuel consumption and CO2 emissions of diesel power units using optimized operation and alternative fuels., Final Report **2021**, https://www.aramis.admin.ch/Default?DocumentID=67587&Load=true

Effective Density and IPSD Measurements of solid PM from a Lean and Stoichiometric GDI Engine Operating on Ethanol Blends

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Gasoline direct injection (GDI) engines are coming into widespread use in light-duty vehicles because of their increased power output and reduced fuel consumption and CO2 emissions. However, GDIs tend to produce higher particulate matter (PM) emissions, especially lean burn engines. In this study, particle number, size, and mass concentration; effective density; and mass-mobility exponent are measured for a GDI engine fueled with E10, E30, and E50 and operated in three combustion modes: stoichiometric (2000 RPM 7 bar BMEP); lean homogeneous (2000 RPM 7 bar BMEP); and lean stratified (2000 RPM 4 bar BMEP). The focus of this study is on solid particles, so all measurements are made behind a catalytic stripper. Two different methods for measuring effective density are compared: DMA-CPMA-CPC and CPMA-SMPS configurations. Using the measured effective density functions and particle size distributions, solid particle mass is calculated using the integrated particle size distribution (IPSD) method and compared to black carbon mass measured with a Micro Soot Sensor (MSS).

With the baseline fuel E10: (1) Stoichiometric (S) operation produces the lowest particle concentration, a broad size distribution with a hint of a nucleation mode, and the highest effective density; (2) Lean homogeneous (LH) operation leads to slightly higher particle concentration than S, a narrower, more peaked unimodal size distribution, and the lowest effective density; (3) Lean stratified (LS) operation produces much higher particle concentrations than S and LH, a broad, nearly flat, but clearly bimodal size distribution, and effective densities slightly higher than LH, but considerably smaller than S.

Increasing the ethanol content to E30 and E50: (1) under S conditions decreases number and mass concentrations, narrows the size distribution, and slightly decreases density; (2) under LH conditions increases mass and number concentrations, broadens, and flattens the size distribution, and significantly increases density; (3) under LS conditions, strongly decreases mass and number concentrations, narrows the size distribution, and has little influence on effective density.

Combustion strategy has a clear influence on the ratio of IPSD to MSS mass with the ratio increasing from S to LH to LS, suggesting a decrease in the light absorbing cross section of the PM.

Although there have been reports elsewhere of differences between effective densities measured using the DMA-CPMA-CPC and CPMA-SMPS configurations, our measurements showed no difference within experimental uncertainty.

Measurement of brake and tyre wear emissions from a battery electric vehicle

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Non-exhaust particle emissions already dominate the European transport sector [1]. Knowledge of the quantity and size distribution of the emitted particles is essential for hazard assessment and reduction. Standardized tests use component test bench measurements to determine brake and tyre emissions. Although these offer comparable results, the test conditions differ strongly from those on the vehicle. The objective of this study is to determine and characterize the ultrafine particle emissions from a battery electric car under realistic conditions.

The experiment was performed with a BMW i3 test vehicle, equipped with measuring instruments and a customized sampling setup. This includes a separate encapsulation of brakes and tyres which enables direct source allocation. An adjustable ventilation with pre-filtered air is set based on a real drive scenario without modifications and, thus, ensures realistic brake temperatures. Real driving experiments were performed in the area of Stuttgart under different traffic conditions (urban, rural, highway). Additional tests with braking patterns and cornering scenarios were performed on a test site. The particle measurement instrumentation is connected to an isokinetic sampling at the back of either the brake or the tyre housing. Total particle number concentration between 4 nm and 3 µm is measured by a TSI Condensation Particle Counter. A combined use of an Engine Exhaust Particle Sizer (TSI) with an Optical Particle Sizer (TSI) determines the real-time particle size distribution between 5.6 nm and 10 µm. Monitoring the background concentration with a second Condensation Particle Counter enables the identification of particles emitted in the semi-closed tyre housing.

Real driving tests show a strong dependence of non-exhaust emissions on driving conditions. Braking emissions occur despite recuperation and are highest at high speeds. Tyre emissions depend primarily on longitudinal and lateral vehicle acceleration.

Acknowledgment: This work was carried out as part of the ZEDU-1 (Zero Emission Drive Unit – Generation 1) project and is supported by the Baden-Württemberg Ministry of Economics, Labour and Housing.

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Real-World Brake and Tire Wear PM Emissions Near Californian Highways

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Brake and tire-wear particulate matter (PM) is a large fraction of non-exhaust PM emissions from vehicles. CARB's legislative effort has resulted in much lower tailpipe PM emissions over the years but has not affected non-exhaust PM emissions. Thus, non-exhaust sources, including brake and tire-wear PM, have become larger contributors to traffic-related emissions. An additional concern is that these particular sources have high metal content, which could result in higher toxicity and negative influence on impacted communities, and therefore it is critical to improve our understanding of the impact of brake-wear PM emissions.

The objective of this study is to quantify the real-world impact of brake and tire-wear emissions on PM concentrations near highways. The findings from this study will support ambient air quality attainment strategies and state implementation plans as well as health studies related to toxic PM constituents.

The size distribution, chemical composition, dispersion characteristics and emission rates of brake and tire-wear PM will be characterized and their importance relative to tailpipe exhaust and other regional background sources will be calculated. The results of this study will be used to verify laboratory generated brake and tire-wear PM emission factors and quantify PM contributions from vehicular sources (tailpipe and non-tailpipe) near roadways. The results will also help provide exposure information to examine possible health impacts of these sources on nearby receptor populations.

The presentation will include detailed results from the project.

A new device for fast solid-volatile nanoparticle differentiation

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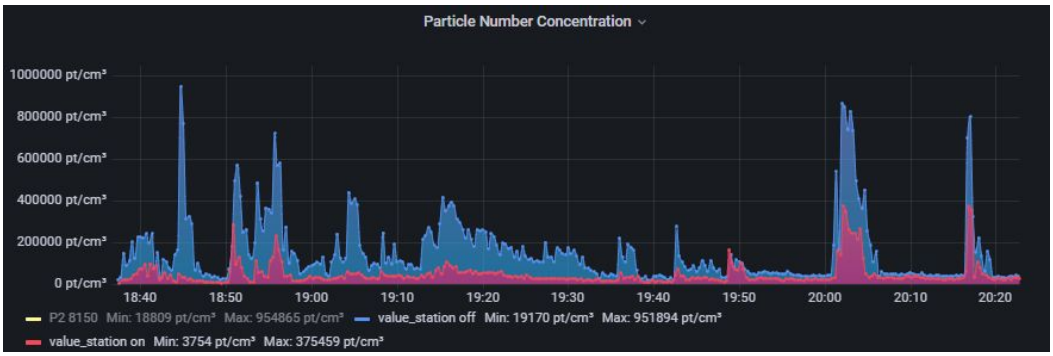
[1]Naneos particle solutions

Traditionally, many nanoparticle measurements measure purely physical properties, such as particle mass or number. However, for the assessment of health risks, such measurements are incomplete due to the lack of information on the particle chemistry. Unfortunately, proper time-resolved chemical speciation e.g. with mass spectrometers is expensive and complex. One characteristic of nanoparticles that is comparatively easy to measure is their volatility, and this property has also been applied to emissions standards for vehicles and aircraft, where only nonvolatile particle are measured.

Here, we present a new device to monitor aerosol volatility with high time resolution and comparatively low cost. The device consists of a catalytic stripper and an "Advanced Partector" OEM sensor as particle detector, which measures lung-deposited surface area (LDSA), average particle diameter and particle number. The catalytic stripper can be bypassed by switching a valve every 10 seconds. Compared to a traditional particle number counter, this system delivers additional information on particle size and volatility, at still reasonably high time resolution, and in a system that can be operated without intervention over long periods of time (months).

As an example application, we present data measured at Zürich airport. Nanoparticle emissions of aircraft are of health concern; in particular the nonvolatile fraction. However, airport emissions are highly dynamic and a high time resolution is necessary to accurately measure the short-lived exhaust plumes of individual airplanes. The following figure shows an example of data measured at Zürich airport in February 2022:



As can be seen in the figure, it is often possible to determine the volatile fraction for each individual peak, and some airplanes produce large fractions of nonvolatile particles (20:00, 20:20), whereas others produce practically only nonvolatile particles (18:45). In contrast to a CPC, which provides only number concentration, our new device also measures an average particle diameter which can be used to differentiate airplanes (which often produce particles of ~10nm diameter) from ground vehicles which produce much larger particles (~70nm).

In summary, we have demonstrated a new device that may be useful for monitoring in places where the volatility of aerosols is of interest, such as at airports.

Characterising the Silver Particle Generator: a pathway towards standardising aerosol generation

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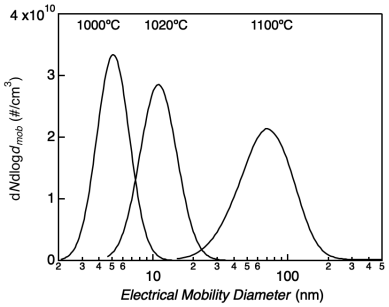
Reference aerosols for the calibration of common aerosol instruments, such as condensation particle counters (CPCs) and differential mobility analyzers (DMAs), must be stable and reproducible in concentration and particle size, ideally monodisperse and non-volatile and comprise a uniform non-reactive material [1]. To that end, we present a detailed evaluation of the aerosol with regards to number, size, inter- and intra-day stability, and aerodynamic properties of the aerosol properties of the new Silver Particle Generator (SPG) from Catalytic Instruments.

The aerosol production in the SPG resembles that of a classic tube furnace, however, the device offers 1-touch button operation and is simple for the user to set up and configure, and offers long-term stability using controlled standardized procedures and operation settings. Out of the box, the SPG has two operational modes (Modes 1 & 2 for the smallest and largest aerosol, respectively). These modes merely correspond to temperature set points for default flow operation (Mode 1 = 1000 ºC, Mode 2 = 1100 ºC). The user can finely tune the temperatures and flows to achieve their desired output (Figure 1). GMD range is around 1 nm to 70 nm, and the largest aerosol in significant concentrations (i.e. > 1×10^3 #/cc) is over 200 nm in diameter. In addition, the shape and size of the aerosol, as well as the effects of sintering were assessed using transmission electron microscopy (TEM), SMPS and aerodynamic aerosol classifier (AAC).



Suitable applications of the SPG include the calibration of CPCs, DMAs, particle number counters (PNCs), VPR systems, PMP and PCRF compliances, and the characterisation of particle number - portable emissions measurement systems (PN-PEMS) systems.

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The organic coating unit, an all-in-one system for reproducible generation of secondary organic aerosol

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Secondary organic aerosol (SOA), particularly from biogenic origins, is the largest organic aerosol fraction (IPCC 2013, 2013). Most of our understanding of SOA comes from environmental chamber experiments. But complexity and cost factors prevent the use of these installations in day-to-day tasks. Oxidation flow reactors (OFR) offer a faster, portable and more economic approach to, e.g., model properties of “fresh” and “aged” combustion particles in ambient air (Ess et al., 2021). But they are still not sufficiently standardized, and their operation requires considerable experimental effort.

Within the framework of the EMPIR Aerotox project, our goal was to miniaturize and automate the aerosol generation procedure. We built a compact SOA generator called Organic Coating Unit (Keller et al. submitted; figure below). The device incorporates a humidifier, two systems for dosing VOC precursor substances, a compact OFR, and control electronics. This all-in-one instrument produces pure SOA particles or, when used in combination with a standard aerosol generator (e.g., a diffusion flame soot generator), coats very diverse primary particles with a controlled amount of secondary organic matter. Applications include intercomparison of black carbon measuring instruments (Kalbermatter et al., 2022), filter testing, as well as more basic health and climate-related studies. Tests performed on 3 different units by independent laboratories show an excellent unit to unit reproducibility. We will show stable operation points and characterize the physicochemical properties of the generated aerosols with an array of methods, including transmission electron microscopy (TEM), thermal-optical analysis and liquid chromatography coupled with mass spectrometry (LC-MS). This all-in-one instrument is robust, portable and user-friendly, making it ideal for laboratory or field-based aerosol studies.

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A dual-wavelength photothermal aerosol absorption monitor: design, calibration and measurements of absorption enhancement due to coating

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The direct measurement of aerosol light absorption coefficient with the photothermal interferometer probes the change of the refractive index caused by light absorption in the sample. Measurement at two wavelengths determines its wavelength dependence - the Ångström exponent (AAE). **The photothermal aerosol absorption monitor** uses a folded Mach-Zender interferometer. Two pump lasers at 532 and 1064 nm are modulated at different frequencies and focused in the sample chamber using an axicon (patent pending) for simultaneous measurement. The interferometer signal is detected by photodiodes and lock-in amplifier at the two respective frequencies. The green channel is calibrated traceably to primary standards using ~1 µmol/mol NO_2. The calibration is transferred to the IR using aerosolized nigrosin (Drinovec, 2022). **The uncertainties for absorption coefficients at 532 and 1064 nm and AAE were 4%, 6% and 9%, respectively**. We calibrated filter photometers (in green and IR. A **winter ambient campaign** has shown similar multiple scattering parameter values for ambient aerosols and laboratory experiments. The spectral dependence of these parameters resulted in AE33 reporting AAE biased 0.17-0.3 higher than the PTAAM measurement. We determined the **absorption enhancement** E_{babs} (532 nm) using laboratory measurements with uncoated and soot coated with secondary organic matter (SOM). Fig. 1 shows its dependence on the mass of organic coating over the mass of uncoated soot $R_{BC}=(M_{total}-M_{BC})/M_{BC}$ (Kalbermatter, 2022).

We thank SNSF (200021_172649), EUROSTARS (11386), Slovenian Research Agency (P1-0385, P1-0099, I-0033), and EMPIR (Black Carbon, AeroTox).

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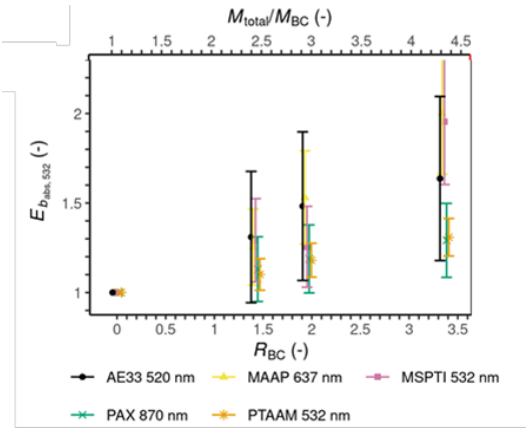

Figure 1. Absorption enhancement due to coating with SOM as a function of the relative coating mass R_{BC}. Filter photometers overestimate E_{babs} compared to PAX and PTAAM (Kalbermatter et al., 2022).

In-situ Characterization of Catalyst Nanoparticles from Reactive Spray Deposition Technology (RSDT)

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Reactive Spray Deposition Technology (RSDT) is the state-of-the-art for manufacturing Membrane Electrode Assemblies (MEAs) for fuel cells, water electrolyzers, and batteries. This one-step flame-based process synthesizes and deposits catalytic nanoparticles with tailored properties controlled by the RSDT operating parameters. Nanoparticles are collected and analyzed ex-situ at the end of the deposition to optimize the operating parameters of RSDT so that Laser diagnostics can accelerate the RSDT optimization and provide information about the synthesized nanoparticles by measuring in-situ their properties.

A horizontal turbulent diffusion flame synthesizes the nanoparticles in the RSDT. The metal precursor is seeded in the flame fuel and goes through the decomposition and particle nucleation, growth, and coagulation stages [1]. In this study, we investigate two flames fueled by a 10mM solution of platinum acetylacetonate in xylene, acetone, and liquid propane with different flow rates (Pt-Type1 and Pt-Type2) and a flame fueled by a 9mM iridium acetylacetonate (Ir-Type1) solution in xylene, DGME, ethanol, and propane. The three flames are used with identical RSDT parameters but deprived of the solute catalyst precursors (Pt-Blank1, Pt-Blank2, Ir-Blank1) for discerning the nanoparticle signal from that of the gaseous products of the flame.

Laser-induced incandescence (LII) is used to measure the volume fraction of the synthesized nanoparticles at various distances from the nozzle of the flame, L [2]. In particular, we measure the LII signal at the edge of the flame, where the volume fraction can be found through a mass balance from the catalyst metal seeded in the flame. The volume fraction is measured by comparing the measured LII signal at various L with the signal at the edge of the flame, whereas Laser light scattering (LLS) measures the size of the nanoparticles [3] upon calibration in pure gases (C_3H_8, CO_2, N_2, He) with known scattering cross-section. The average light scattering equivalent diameter, $d_{6,3}$, is determined by the calibrated background-subtracted LLS signal and the measured volume fraction. Raman scattering is applied in the iridium flame to detect possible peaks related to nanoparticle composition. The laser results are compared with that obtained for samples collected via thermophoresis from the flames and characterized via ex-situ using High-Angle Annular Dark-Field Scanning Transmission Electron Microscopy (HAADF-STEM) image analysis.

Laser diagnostic results are consistent with the HAADF-STEM measured nanoparticle sizes and the growth rate of the nanoparticles was found to be orders of magnitude slower than those predicted for non-interacting Brownian particles. Finally, the Raman spectrum of iridium flame indicates the attachment of a carbonyl group on the synthesized nanoparticles.

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Airport emission particles: exposure characterization and toxicity following intratracheal instillation in mice

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Background: Little is known about the exposure levels and adverse health effects of occupational exposure to airplane emissions. Diesel exhaust particles are classified as carcinogenic to humans and jet engines produce potentially similar soot particles. We evaluated the potential occupational exposure risk by analyzing particles from a non-commercial airfield and from the apron of a commercial airport. Toxicity of the collected particles was evaluated alongside NIST standard reference diesel exhaust particles (NIST2975) in terms of acute phase response, pulmonary inflammation, and genotoxicity after single intratracheal instillation in mice.

Results: Particle exposure levels were up to 1 mg/m^3 at the non-commercial airfield. Particulate matter from the non-commercial airfield air consisted of primary and aggregated soot particles, whereas commercial airport sampling resulted in a more heterogeneous mixture of organic compounds including salt, pollen and soot, reflecting the complex occupational exposure at an apron. The particle contents of polycyclic aromatic hydrocarbons and metals were similar to the content in NIST2975. Mice were exposed to doses 6, 18 and 54 µg alongside carbon black (Printex 90) and NIST2975 and euthanized after 1, 28 or 90 days. Dose-dependent increases in total number of cells, neutrophils, and eosinophils in bronchoalveolar lavage fluid were observed on day 1 post-exposure for all particles. Lymphocytes were increased for all four particle types on 28 days post-exposure as well as for neutrophil influx for jet engine particles and carbon black nanoparticles. Increased *Saa3* mRNA levels in lung tissue and increased SAA3 protein levels in plasma were observed on day 1 post-exposure. Increased levels of DNA strand breaks in bronchoalveolar lavage cells and liver tissue were observed for both particles, at single dose levels across doses and time points.

Conclusions: Pulmonary exposure of mice to particles collected at two airports induced acute phase response, inflammation, and genotoxicity similar to standard diesel exhaust particles and carbon black nanoparticles, suggesting similar physicochemical properties and toxicity of jet engine particles and diesel exhaust particles. Given this resemblance as well as the dose-response relationship between diesel exhaust exposure and lung cancer, occupational exposure to jet engine emissions at the two airports should be minimized.

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Respiratory health effects of aircraft emissions: an in vitro study for evaluating the toxicity of non-volatile particulate matter from an aircraft turbofan engine on bronchial epithelial cells

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Aircraft emissions contribute to local and global air pollution. Health effects of particulate matter (PM) from aircraft engines have not been adequately investigated, since controlled laboratory studies reflecting realistic conditions regarding aerosols, target tissue, PM exposure and deposited particle dose are logistically challenging. However, given the documented health effects of particle emissions generated from gasoline and diesel combustions, it is of importance to unravel the impact of aircraft generated emissions on human health.

We examined the respiratory effects of non-volatile PM (nvPM) emitted from a run-in CFM56-7B26 turbofan, one of the most common aircraft engines in the world, by using a unique experimental setup for particle sampling and cellular deposition. The nvPM were directly sampled from the engine exhaust under realistic engine operating conditions and deposited onto air-liquid-interface cultures of human bronchial epithelial cells (BEAS-2B) and re-differentiated human bronchial epithelia (HBE) derived from normal and health compromised donors using the Nano-Aerosol Chamber for In vitro Toxicity (NACIVT). We evaluated acute cellular responses after 1-hour of exposure to diluted exhaust from combustion of conventional or alternative fuel. Cytotoxicity, cytokine release and oxidative stress were measured at 24-hour post-exposure. Morphological characteristics of soot were examined by High Resolution Transmission Electron Microscopy (HRTEM).

Particle deposition varied depending on the engine thrust levels, with 85% thrust producing the highest nvPM mass and number emissions. The HRTEM analyses of soot revealed varying reactivity matching the observed cellular responses. Single, short-term exposures to nvPM impaired both BEAS-2B and HBE cell cultures, whereby nvPM from conventional fuel at low thrust levels was found to be the most hazardous. A decrease in the secretion of interleukin 6 and monocyte chemotactic protein 1 was observed in HBE following exposure to nvPM from conventional fuel. Multiple exposures of epithelia from a normal donor to nvPM primarily resulted in a pro-inflammatory response, while both cytotoxicity and oxidative stress induction remained unaffected.

More severe responses at lower mass concentrations suggest that additional metrics are necessary to evaluate health risks of this increasingly important emission source. Our results support the need to further characterize the pulmonary toxicity of aircraft engine exhaust, especially in occupational settings.

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Airport-related ultrafine particles and risk of malignant brain cancer among Los Angeles participants in the Multiethnic Cohort Study

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Ambient air pollution may reach the brain via systemic circulation, increasing the risk of malignant brain cancer development. Using published exposure assessment methods, we investigated the relationship between long-term airport-related ultrafine (UFP) exposures and risk of malignant brain cancers. In this cohort analysis of 155 malignant brain cancers diagnosed among 75,936 cohort participants with 16.4 years of follow-up, risk of malignant brain cancer increased significantly 14% per interquartile range increase in UFP after adjusting for individual and neighborhood factors and PM_{25} exposures. Our results add to the evidence that air pollution may be a risk factor for malignant brain cancer.

Nanoparticle-Triggered Reactivation of Latent Virus Infection – A Link between the Inflammatory Response to Air Pollutants and Chronic Lung Disease

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Introduction

Particulate air pollution and gammaherpesviruses are omnipresent in human society and almost every adult person is infected by at least one virus. These viruses persist lifelong in the host in a latent state, and switch to a lytic and replicative phase upon reactivation. We have previously shown that pulmonary exposure to carbon nanoparticles (CNPs), a typical component of urban air pollution, and engineered carbon nanotubes (CNTs) can lead to the reactivation of latent murine gammaherpesvirus 68 (MHV-68) in the lungs of mice. Boosting the production of lytic proteins and subsequent immunomodulation by repetitive CNP and CNT inhalation scenarios might contribute to the exacerbation of chronic lung diseases like COPD and pulmonary fibrosis. Here we test whether a repeated nanoparticle exposure potentially triggers additive pulmonary inflammatory effects in the MHV-68 virus reactivation mouse model and thereby might contribute to exacerbations of chronic lung diseases.

Results

Repeated intratracheal dosing of MHV-68 infected mice with 50µg soot-like carbon nanoparticles (CNP) or engineered carbon nanotubes (DWCNT), at a time interval of 55 days, caused increased and prolonged bronchoalveolar lavage (BAL) lymphocyte numbers in MHV-68 infected and particle treated mice, not observed in animals infected or nanoparticle treated only. The over one week after the last exposure rising T-cell dominated lung lymphocyte infiltration was accompanied by increased levels of pulmonary *Tnf, Saa3* and *Spp1* gene expression, elevated BAL protein and IgM levels and mean cord length, all together indicating progressive emphysema like alveolar barrier damage. Lung damage furthermore was associated with high serum concentrations of the acute phase reactant SAA3, suggesting systemic inflammation.

Conclusions

These observations suggest that repeated nanoparticle exposure of latently gamma herpesvirus infected lungs leads to a prolonged inflammatory response with alveolar-capillary barrier disruption and potential systemic consequences, which may contribute to air pollution related exacerbation of chronic lung diseases or cardiovascular disease.

Impact of combustion-generated particles on respiratory response to viral infection

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Combustion-generated particles are a growing source of PM in many parts of the world due to the growing incidence of wildfires due to climate change. The respiratory system is also a prime target for concurrent exposures to inhaled combustion-generated particles, as well as viruses. Epidemiological evidence suggests that wildfire smoke exposure increases potential for symptoms and severe disease induced by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is responsible for the ongoing pandemic. Additionally, controlled exposure data to a wildfire smoke model, wood smoke, indicates sex-specific altered respiratory host defense responses to influenza. Recent mechanistic data from *in vitro* exposure of primary nasal epithelial cells to wood smoke and SARS-CoV-2 has also demonstrated dampened immune gene expression critical for response to viral infection, particularly in females. This talk will summarize what is known about the impact of combustion-generated particles, particularly models of wildfire smoke, on respiratory host defense responses when exposed to viral infections and highlight needed future research.

Inhalation Exposure to Wildfire and Burn Pit Smoke: A Common Etiology for Neurogenic and Oncogenic Diseases of the Brain Involving Iron?

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Accelerating atmospheric warming gives rise to many new challenges in terms of heavy air pollution from globally increasing forest fires, and additional uncontrolled burn pit operations in regional warfare combat zones which contribute their own highly specific fingerprint of poisonous air pollution. Both gaseous and particulate constituents are essential contributors for adverse effects and disease formation. Record-breaking emissions in 2021 into the atmosphere from wildfires (*i.e.,* in the US the Dixie Fire emitted 83 million tons of carbon and plumes of smoke) and from burn pits (*i.e.,* during the Iraq war individual burns of ~200 tones/day of diverse waste-materials) have been documented. Acute and long-term adverse effects have been reported from wildfire exposure in firefighters and the general population both in the respiratory tract and also in secondary organs including cardiovascular, central nervous (CNS) and other systems. Likewise, burn pit exposure of veterans also induced respiratory tract effects; however, a major concern has arisen over the years linking burn pit smoke inhalation to brain tumors, specifically their deadliest form of glioblastoma multiforme. Burn conditions for wildfire and burn pit smoke range from open flame to smoldering, emitting airborne particles varying from ultrafine to micron size. Inhaled nano-sized particles (ultrafine particulates “UFP”) depositing on the nasal olfactory mucosa translocate to the olfactory bulb (OB) of the brain which provides a direct immediate pathway for airborne particles to the CNS as we demonstrated at the previous ETH conference using ultrahigh resolution analytical imaging. Our present results indicate the highly reactive nature of freshly generated smoke which – depending on dose – causes oxidative stress at target cells and induces inflammation, which then can progress to activate and interact with macro and microglia target cells. We hypothesize that neuro inflammation initiated by translocated UFPs represents a common mechanism preceding neurogenic and oncogenic effects in the CNS, where increased glial cell proliferation and mutational events may play a critical role for tumorigenicity. Important events associated with translocated UFPs during inflammation are the simultaneous presence of bioprocessed iron (Fe) of endogenous (biomineralized) and exogenous (ambient aerosols) origin. It has been postulated that excessive Fe deposits in the CNS are regulated by inflammatory macrophages as a line of attack and defense, but the key processes and mechanisms that operate at the nanoscale may be triggered by influx and buildup of translocated UFPs and continue to evolve. Our approach uses analytical high-resolution scanning transmission electron microscopy (STEM) of tissues coupled with electron energy loss spectroscopy (EELS) to assess composition, relative quantities, and dispersion as well as redox-activities to help identify the nature and physiochemical fingerprints of not only the UFPs that enter cells, neurons, and interstitial space, but also identifies the transformations of UFPs after uptake and new formations of Fe-containing phases around the invader particles. For example, we demonstrate for the first time that Fe-phosphate crusts cover heavy metal and transition metal UFPs (i.e., Pb, W, Hg, As, Zr, Ti, Mn, Co, Ni, Cr) while copious ferritin nanoparticles (Fe-oxyhydroxide) form clouds in the vicinity of the invader UFPs in OB tissues and in deeper brain regions as indicator of modifying inflammation. The location and frequency of endogenous Fe near invader particles clearly helps to find the UFPs inside the tissues with improved accuracy since there is now a greater contrast with STEM due to the buildup of Fe. However, this Fe accumulation further increases the particulate load in the already affected tissues and, hence, may be implicated in brain dysfunction since several neurological disorders and glioblastomas show elevated Fe (endogenous origin) which does not get cleared effectively. Our investigations show the initial stages of Fe buildup at the nanoscale when pollution particle uptake first occurs. The initial ferritin deposits occur independent of whether the UFPs contain exogenous Fe. Our discovery of the formation of Fe-phosphate crusts at the nanoscale are expected to help gain insights into the *in vivo* reactivity of UFPs that come from wildfires and or burn pit sources. Specifically, our study represents a first basic analysis of the mechanistic underpinning of the connection between UFP-resultant inflammation and initiation of Fe-buildup to understand the overall biological responses that control a common etiology for neurogenic and oncogenic diseases of the brain. Funding: NIH 1R01AG067497-01

Indoor Protection from Viruses and Combustion Generated Nanoparticles

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In the last two years of the pandemic, we have learned that the most important way viruses are transferred from one person to another is via indoor aerosols. To avoid infections this virus aerosol transfer has to be minimized. This requires on the one hand a virus free supply of air to the room, on the other hand a flow regime which avoids air transfer from one person to another, i.e. horizontal flow. One way to achieve this is establishing a vertical flow upwards. Upwards is essential because this flow direction is supported by the thermal convection induced by each individual person. So the first requirement is a ventilation system, achieving this vertical flow of the virus aerosol in the whole room. To avoid excessive energy loss (by heating in winter or cooling in summer) the air must be recirculated and this requires filtration of the viruses with an efficiency close to 100%.

We showed that the viral filtration can be done using ceramic wall flow filters as applied for gasoline particle filters (GPF). As it takes long time to build up a filter cake when filtering ambient air these filters have to have the high efficiency already from the beginning. Extensive tests with MS2 bacteriophages used as virus surrogate showed that the MS2 bacteriophages are precipitated with very high efficiency by these filters and that the lifetime in the filter is short enough to avoid the need for additional decontamination measures. Nevertheless, these filters can be heated from time to time in applications, where bacteria or fungi could be a problem.

In a case study we installed a ventilation system in a classroom. Six porous tubes on the ceiling are used to establish the required vertical flow. The air, succeed via these tubes, is mixed with outdoor air, the amount of outdoor air being controlled by the CO_2 concentration in the room. This mixture is then passed through the ceramic filter and recirculated into the room at the bottom.

Tests by flow visualization show the vertical flow direction. Measurements when aerosol sensors are placed on each desk of the classroom and an aerosol source (nebulizer, distributing NaCl aerosols) show that the concentration on all desks is more than two orders of magnitude smaller than the source concentration. This proves that the vertical flow is achieved in the whole room. This experimental result are corroborated by simulations.

The concept, presented above not only allows to minimize the infection risk in indoor environments. In addition, the air entering from outdoor is filtered, reducing the health risks due to traffic emissions etc.

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Evaluating clean air technologies for mobile air purifiers

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Background: Most people in the developed world spend more than 90 percent of their time indoors. Hence, good indoor air quality is important for public health. In the short term, improvements of indoor air quality may be achieved by mobile air purifiers (MAPs), which are produced in all price classes using different clean air technologies. Several questions arise: 1) Are MAPs efficient in removing particles and gasses? 2) Are MAPs capable of removing viruses? 3) Are MAPs as efficient as promised by the producers? 4) Do MAPs themselves contribute to air pollution? To answer these questions, we have conducted laboratory tests of i) The removal efficiency of particle mass, particle number, volatile organic compounds (VOCs,) and viruses in air; ii) The generation of harmful byproducts (ozone and VOC's). Results are compared with the purifier product information (promised efficiency) and evaluated across the different clean air technologies. **Materials and methods: M**ore than 50 air purifiers for private homes were identified in Denmark. From these, 29 MAPs using different technologies were chosen for detailed laboratory tests. When testing, all MAPs are new, all available filters are used, and all air-purifying functions are activated on highest level unless the purifier automatically selects the level by auto-function. The test chamber is a 20 m^3 airtight and closed room covered in Teflon to minimise particle and gas adsorption, which makes it appropriate for testing the efficiency of MAPs.**Test procedures:** Particles and VOCs are generated from smoking cigarettes in a fully automatic process utilizing a smoking robot. The test procedure is a modified version of the standard for measuring performance of Portable Air Cleaners (ANSI/AHAM AC-1-2015). The test characterizes the cleaning efficiency against both ultrafine, fine and coarse particles, as well as VOCs. The test period lasts for 30 minutes after the smoking phase ends during which all parameters are measured continuously (time res. 10 seconds). A reference measurement is performed to account for natural decay, adsorption, and sedimentation of particles and VOCs. The potential generation of ozone from the devices is characterized using an Ozone Analyzer, which measures the interval with a 0.5ppb accuracy and a lower detection limit of 2ppb. Six different MAPs representing different technologies have been selected for testing efficiency to remove viruses from the air. The test is performed with a unit installed in a closed 20 m^3 test chamber using a modified version of the *ISO16000-36:2018* standard. The effectiveness of the MAPs is tested against a virus model consisting of MS2 bacteriophages (ATCC 15597-B1). MS2 bacteriophage is preferred as this a recognized model virus for non-enveloped virus. The inactivation rate of the aerosolized MS2 is determined as the difference between the natural inactivation rate and the inactivation rate measured during operation of the test unit for 30 minutes. **Findings:** The CADR results for the 29 different MAPs differ significantly. The worst performing devices show no cleaning capabilities, whereas the best demonstrates a CADR for particles of more than 400. A tentative general conclusion is that HEPA-based MAPs outperform other clean air technologies based on the particle CADR values. It is found for all MAPs that the CADR for VOCs is significantly lower than for particles. Detailed results of various parameters, e.g., noise levels, particle size efficiencies, and analysis of "auto-function" offered for some of the devices, are to be performed and presented at the conference along with results from the test against airborne viruses. **Perspectives:** The results might help set efficiency requirements for MAPs in the Nordic Eco-label and the EU's Ecodesign Directive. Further, the eight best MAPs were tested in situ in a private home (other ETH poster submission). **Acknowledgement:** These experiments have only been possible due to the financial support of Realdania Foundation and The Danish Landowners' Investment Foundation (Danish: Grundejernes Investeringsfond).

From roadside to lab with elegant roundworms

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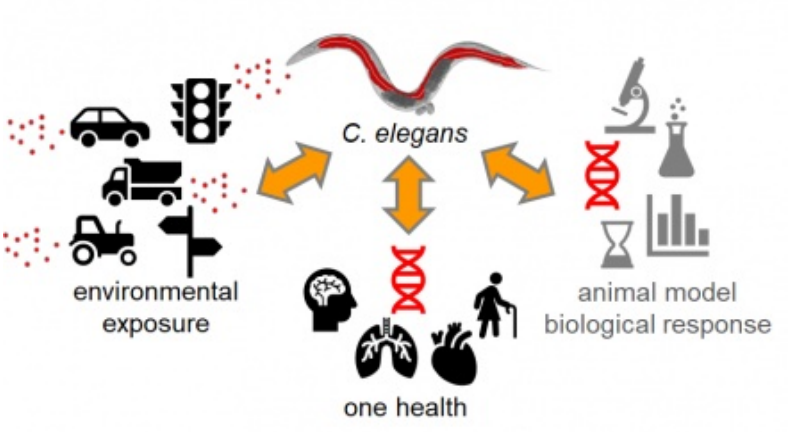
The nematode roundworm *Caenorhabditis elegans* represents a well-characterized animal model in the laboratory or occurs globally in wild habitats. The power of *C. elegans* manifests in genetic amenability, a nervous system with a map of all neurons and many neural circuits and a short adult life span of 2-3 weeks that enables the investigation of biological processes throughout the whole life of the worm. As it shares 60-80% of genes, including disease genes, as well as important molecular pathways with humans, *C. elegans* has the potential to elucidate bio-interactions of traffic-related nanoparticles and provide results for the one health paradigm.

Here, we suggest to go one step beyond in particle toxicology. Probabilistic and dynamic modelling of pollutant flows in environmental compartments together with the habitats of wild *C. elegans* predicts where the nematode is exposed to nanoparticles. In the case of traffic-related nanoparticles exposure of free-living soil nematodes likely occurs in environmental sinks such as soils along roadsides, *e.g.* motorways. By an innovative approach we bring the field into the lab. Isolation and cultivation of nematodes from roadside soil represents a promising strategy to bridge environment and laboratory. This approach aims at toxicological tests with *C. elegans* or other free-living soil nematodes that are sampled from soil along motorways and taken into laboratory culture. The sampled nematodes are subjected to single worm proteomics and characterized with respect to gene expression and the usage of molecular pathways.

While it is acknowledged that conventional laboratory methods require a certain degree of adaptation, our project aims to close gaps between environmental exposure and biological responses by comparative investigations between *C. elegans* or other soil nematodes sampled from unpolluted vs. polluted habitats and the laboratory animal model.

Von Mikecz, A., Scharf, A. Pollution – bring the field into the lab. *Nature* 602: 386 (2022) doi: https://doi.org/10.1038/d41586-022-00444-5



Generation and characterization of ultrafine soot particles with similar physical but varying chemical properties enabling differential toxicological assessment in human lung cells

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Scientific Context: The contributions of ultrafine particles (UFPs, $D_p \leq 100$ nm) to adverse human health effects are debated [1]. Studies analyzing the composition and biological effects of UFPs from various emission sources remain limited and it is currently not fully understood which physical or chemical characteristics are responsible for their specific response [2]. Whether the physical characteristics contribute most or the particles primarily act as carriers of biologically reactive chemicals, rendering the biological responses is vastly unknown [3]. An additional challenge is that biological response is often influenced by several particle properties at the same time [4]. Thus, the fundamental investigation of such cause-and-effect mechanisms requires sophisticated studies in which the physico-chemical parameters of UFP could be adjusted in a targeted and reproducible manner. Hence, laboratory conditions are a strict requirement to assess these processes and their importance for adverse health effects and thus the production of reliable and reproducible data on UFPs is pertinent [4].

Approach: Generation and characterization of ultrafine soot particles of similar elemental carbon core with changing chemistry i.e., high ($UFP_{high\ OC}$) and low organic content ($UFP_{low\ OC}$) to investigate different biological responses in human alveolar epithelial A549 cells at the Air-Liquid-Interface (ALI). **Methods:** The miniature combustion aerosol standard soot generator (MiniCAST) was used to generate ultrafine soot particles. A catalytic stripper (CS) along with honeycomb activated carbon denuders were used for removing organic compounds depending on their volatility. Two classes of UFP soot, depending on the applied temperature in the CS (residence time 0.35 s) were generated and further characterized. Physical characterization was done concerning particle number concentration, particle mass concentration, mobility diameter and aerodynamic diameter. While the chemical characterization of the derived particles was done in terms of organic (OC)/ elemental carbon (EC) ratio, black carbon (BC) and quantification of polycyclic aromatic hydrocarbons (PAHs). Subsequent exposure of A549 cells at ALI was carried out and the effects of ultrafine soot on metabolic activity, cytotoxicity (LDH release) and xenobiotic metabolism (EROD/ BROD enzyme activity) were assessed using different biological assays. **Results:** The applied approach allowed us to generate two classes of UFPs, which showed similar physical characteristics but distinctly different chemical loading. The detailed chemical and physical analysis indicated significant different OC content for the two classes. For instance, in case of $UFP_{high\ OC}$, EC= 56.2 µgC /m^3; OC= 19.4 µgC /m^3, whereas, for the $UFP_{low\ OC}$, EC= 49.2 µgC /m^3; OC= 5.3 µgC /m^3. However, the differences in particle mass, particle number and size distribution were not significant, for example, mobility diameter for $UFP_{high\ OC}$ was about 44.3 nm and $UFP_{low\ OC}$ was about 35.5 nm). Our results indicate that an increase of the OC content does not change the response on metabolic activity ($UFP_{low\ OC} \approx 56\%$, $UFP_{high\ OC} \approx 59\%$) and cytotoxicity ($UFP_{low\ OC/high\ OC} \approx 27\%$). However, an increase in xenobiotic metabolism seemed to correlate with the PAHs loading of $UFP_{high\ OC}$. The shown approach allowed us to adjust specific physicochemical characteristics of UFP and link them to specific biological responses.

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How to guide legislation - An introduction to the ETH-NPC Focus Event 2022

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Emission Legislation is nothing we just have to wait for and respect as another divine message but to initiate, to support, to backup, to influence and to control continuously. VERT has started to influence emission legislation 1995 in Switzerland and following this success story in many other countries all over the world. The ETH Nanoparticle Conference has been founded 25 years ago for exactly this purpose, to become an instrument of science and engineering and has definitely been able to fulfill these expectations. In agreement with the superseding principles of “human right for clean air” and “implement best available technology” we have demonstrated, that we can have an impact even internationally and without any political power just by research, technology and clear determination. The focus event presentations this year are good examples for this “unité de doctrine” and will pave the way for future legislation.

Die Emissionsgesetzgebung ist nichts, was wir einfach abwarten und als eine weitere göttliche Botschaft respektieren müssen, sondern wir müssen sie initiieren, unterstützen, begleiten, beeinflussen und kontinuierlich kontrollieren. VERT hat 1995 in der Schweiz begonnen, Einfluss auf die Emissionsgesetzgebung zu nehmen, und nach dieser Erfolgsgeschichte in vielen anderen Ländern auf der ganzen Welt. Die ETH-Nanopartikeltagung wurde vor 25 Jahren genau zu diesem Zweck gegründet, um ein Instrument der Wissenschaft und Technik zu werden und konnte diese Erwartungen erfüllen. In Übereinstimmung mit den übergeordneten Prinzipien "Menschenrecht auf saubere Luft" und "beste verfügbare Technik einsetzen" haben wir gezeigt, dass wir auch international und ohne politische Macht allein durch Forschung, Technologie und klare Entschlossenheit etwas bewirken können. Die diesjährigen Schwerpunktveranstaltungen sind gute Beispiele für diese "unité de doctrine" und werden den Weg für zukünftige Gesetzgebung ebnen.

Role of the new WHO Air Quality Guidelines

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In September 2021, the World Health Organization WHO published new Air Quality Guidelines (AQG) [1] containing a set of new guideline values and a few Good Practice statements, including one on ambient nanoparticles. As a general pattern the new AQG proposes clearly lower concentrations to protect public health than the AQG 2005. The presentation puts the new AQG in context of the scientific evidence and the current air quality to discuss the impact of the new AQG on future regulations. A focus will be given also on the potential impact on the Swiss air quality regulations. So far, the latter were largely compliant with the former WHO AQG.

[1] World Health Organization. (2021). WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. World Health Organization. https://apps.who.int/iris/handle/10665/345329. License: CC BY-NC-SA 3.0 IGO

On the effects of past and future ambient air regulations on air quality in Switzerland
Presentation in the Focus Event 2022: New legislation to guide the world

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Cleaner air due to vehicle approval or vehicle inspection?

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Particle Number measurement (PN) are introduced within the homologation of Euro 5b diesel vehicles since 2011. Although type approval limits for PN, Real Driving Emission (RDE) tests, European On-Board Diagnose (EOBD) and opacity plate value are installed for each new type, fraud by removing the Diesel Particulate Filter (DPF) exists.

The mean reasons for the existing fraud are:

- It is cheaper and easy to cheat than to repair;
- (E)OBD is not able to detect fraud;
- Opacity Plate value is not consistent with Euro 5 and Euro 6;
- Periodic Technical Inspection (PTI) was not able to detect removal of DPF.

Due to the work of CITA members with the collaboration of VERT and the NPTI working group Belgium will start as the first country with PN-counting during PTI. Others like The Netherlands, Germany and Switzerland will follow as from 1.1.2023. The potential benefit in reducing emitted PN is enormously: 91% of the concerned Euro 5 & 6 diesel vehicles. It is a great success.

But if Type approval had also thought on vehicles in services from 2011, the PTI test would be there much earlier. Type approval and PTI should both better integrated in each other to fulfil vehicle continuous compliance!

- Cheating should be made more difficult to introduce and easier to detect;
- EOBD should detect fraud;

Measurement procedure and rejection criteria of type approval and PTI should been fixed together.

New legislation to guide the world: Where are we now and in which direction should we go?

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Where are we now with current vehicle legislation and air quality guidelines? What have we regulated so far, what should we regulate in the future? What can we learn from the occupational health legislation?

Can we assess new technologies and new fuels based on their effects? What are benefits and risks of new technologies and fuels? Can we close the gaps between tailpipe- and occupational health-legislation?

If a threshold limit value is the maximum concentration of a chemical, allowable for a repeated exposure without producing adverse health effects, shouldn't we set new limits for engines and vehicles based on the toxicity of such chemicals?

If new fuels and fuel additives are produced and applied at large scales, e.g. >10'000 t/y, like other high-production volume chemicals, shouldn't we ask for a multi-media risk assessment, including an evaluation of the health and environmental impact?

Shouldn't tailpipe- and occupational health-legislation and air quality guidelines regulate the same compounds? How should we regulate secondary pollutants, which can form down-stream of the engine, e.g. in catalytic converters, in the urban environment, and in aged air masses during atmospheric transport and transformation?

These questions will be addressed in the presentation, which serves as an overview of current vehicle legislation and an outlook for future legislation for new technologies and fuels. To further stimulate the panel discussion, a list of commandments will be presented.

Environmental temperature effects on secondary organic and inorganic aerosols formed from vehicle exhausts

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Introduction & Background:

Fine particulate matter (PM2.5) is classified into primary particles emitted directly from sources and secondary particles produced by chemical transformations of precursor gases, such as photochemical reactions. PM2.5 in the air contains a large amount of secondary particles, and in recent research into the measurement of nanoparticles in vehicle emissions has included secondary particles in its assessment, rather than measuring only primary emissions from the source. However, there is insufficient knowledge of the effect of environmental temperature conditions on the formation of secondary particles. This study investigates the effect of environmental conditions on the formation of secondary particles from vehicle exhaust in a smog chamber experiment.

Methodology:

A mobile photochemical smog chamber was used to measure secondary particles and ozone produced by photochemical reactions from gasoline automobile emissions. The environmental temperature conditions of the mobile photochemical smog chamber and the chassis dynamometer were -7°C, 23°C and 38°C. Diesel and gasoline passenger cars were used in the experiments, and the diesel cars were tested only at 23°C. Vehicle exhaust gas was introduced into the mobile photochemical smog chamber by connecting an ejector diluter (DI-1000) directly to the exhaust pipe of a passenger car running on a chassis dynamometer in four phases of the World Wide Harmonized Light Vehicles Test Cycle (WLTC). The smog chamber volume (reaction volume 7.5 m3) was kept constant with clean air and hydrogen peroxide (H2O2) was added as a source of OH radicals, irradiated with 80 UVA 340 lamps and allowed to react photochemically for 5 hours. Secondary particles were quantified by ion chromatography and carbon component analysis (OCEC analysis, DRI model 2001) after filter collection.

Results & Conclusions:

The chemical composition of the particles detected after the photochemical reaction included Elemental Carbon (EC) derived from primary particles, Organic Carbon (OC) including primary and secondary particles, and ammonium nitrate derived from secondary particles. Comparing gasoline and diesel car exhausts, gasoline car exhausts contain more VOCs, such as aromatic hydrocarbons, which are more sensitive to the formation of secondary particles. Therefore, gasoline car exhausts formed more secondary organic aerosols (SOA) than diesel car exhausts. The effect of environmental temperature on gasoline car exhaust emissions (Figure 1) showed that hydrocarbons (HC) were emitted in sufficient amounts at -7°C compared to 23°C and 38°C. However, the formation of SOA did not increase linearly with the increase in HC emissions at -7°C.This suggests that the decrease in temperature reduces the UV intensity, resulting in a decrease in the amount of photochemical reaction of the HC precursor gas and in the yield of SOA formation.

Next, it is known that the ammonium nitrate particles formed from gasoline vehicle emissions depend on the mixture concentration of NH3 gas and HNO3 gas formed from NOX (Figure 2). Despite the higher emission of NH3 gas at -7°C (circle plot in Figure 2) compared to 23°C (square plot in Figure 2) and 38°C (triangle plot in Figure 2), the amount of ammonium nitrate particles formed is lower.

It is important to take into account not only the amount of emissions but also the photochemical reaction process, depending on the environmental temperature, to evaluate the possible impact on PM2.5 formation in the atmospheric environment.

Assessment of Sub-Micron Particulate Matter and associated Poly aromatic hydrocarbons in indoor and outdoor air of Lucknow city: Capital of the most populated state of India.

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Abstract

The present study was conducted in Lucknow city from 1st November, 2021-28th February, 2022 in three microenvironments namely industrial, commercial and residential. Six houses from each microenvironment were selected for indoor and outdoor monitoring $PM_{2.5}$, $PM_{>2.5}$, $PM_{1.0-2.5}$, $PM_{0.50-1.0}$, $PM_{0.25-0.50}$ and $PM_{<0.25}$, and polycyclic aromatic hydrocarbons (PAHs) associated with $PM_{2.5}$. From each microenvironment 24 samples were collected during the monitoring period. The households were selected on the basis of a questionnaire survey which was primarily done to assess the Indoor/outdoor environment. Monitoring was done for four times in each house. The indoor concentration of $PM_{2.5}$ in industrial, commercial and residential areas ranged between 121-309, 189-289, and 114-299 µg/m^3, whereas the outdoor concentrations were between 299-356, 294-319 and 279-299 µg/m^3 respectively. The average outdoor concentration of $PM_{>2.5}$ in industrial, commercial and residential microenvironments were between 50-60, 51-65 and 31-49 µg/m^3, whereas the indoor concentration ranged between 40-53, 41-59 and 41-49 µg/m^3. The outdoor concentration of $PM_{1.0-2.5}$ ranged between 38-49, 62-76 and 35-74 µg/m^3, whereas, the indoor concentration ranges from 31-62, 51-79 and 51-59 µg/m^3 in industrial, commercial and residential areas respectively. The average outdoor concentration of $PM_{0.5-1}$ ranged between 61-68, 69-76 and 40-59 µg/m^3, whereas the average indoor concentration was found to be between 51-59,50-74 and 50-59 µg/m^3 in industrial, commercial and residential microenvironments. For $PM_{0.25-0.50}$ the observed indoor and outdoor concentration ranged 57-73,59-78,50-60 and 68-85,99-108,48-59 and for $PM_{<0.25}$ the concentration ranges from 84-112,59-81,51-69 and 98-119,86-102,41-59 for indoor and outdoor respectively for the three microenvironment. The contribution of seven carcinogenic PAHs viz. Benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno (1,2,3-cd) pyrene and dibenzo(a,h)anthracene in households situated in industrial, commercial and residential areas was estimated to be 60% ,40% and 39%. A significantly strong correlation between Flu and Phe was obtained in residential households, which may be attributed to their release from combustion of oil, coal, wood and other organic matter. The findings of this study may give a better understanding of the quality of air pertaining to size determined particulate concentrations at various microenvironments which could further help to have an insight of the noxiousness of Sub-micron particles with an improved understanding to regulate them.

Keywords: Poly aromatic hydrocarbons, Sub-micron particles, Incremental Lifetime Cancer risk [ILCR].

The effects of three-way catalyst samples on particulate emissions from a spark ignited single cylinder engine

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Knowledge of the oxidation and formation process of soot on its path into the particulate filter plays an important role in understanding its behavior under defined conditions. This is an important prerequisite for the development of more comprehensive soot aftertreatment and particulate filter monitoring strategies. In this study, an experimental investigation of the interaction between three-way catalyst samples and particulate emissions was conducted on a single-cylinder spark ignition internal combustion engine at the Institute of Thermodynamics of Mobile Energy Conversion Systems (TME) at RWTH Aachen University. The experimental investigations were performed at three different operating points representing low load, high load and operation immediately after a cold start, all including lambda wobbling. Particulate counts were measured with an Engine Exhaust Particle Sizer 3090 (EEPS) up- and downstream of laboratory scaled three-way catalyst (TWC) samples. The samples were a blank cordierite brick, a non-activated TWC with ceria-only coating, a commercial state-of-the-art TWC, and a commercial TWC with a particularly high platinum group metals (PGM) loading. For all four catalyst samples, the total particulate count was lower downstream than upstream of the TWC at all operating conditions. The greatest effect on the particulate number (PN) occurred during low load operation at n=2000 1/min, BMEP=3 bar. At this engine operating condition, the highest PN difference between up- and downstream measurements was observed for the commercial state-of-the-art catalyst sample. Particulates between 6 and 30 nm in size showed the largest changes at lean operating conditions, which can be attributed to oxidizing effects. Despite the PN changes, the particulate size distribution of the none-commercial, ceria-only coated sample maintained its spherical shape during switching from upstream to downstream measurements.

Experimental study on nanoparticles emissions from a TSI E6 vehicle beyond the boundary altitude conditions of the RDE

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The transport sector is one of the human activities with the greatest impact on air pollution. Global warming is increasing due to, in large part, gases produced by said activity, such as CO_2 and NO_x. Indeed, nowadays air pollution is dominated by fine particulate matter with aerodynamic diameter less than or equal to 2.5 µm, product of automobile traffic. Moreover, the exposure to fine particulate matter contributes to approximately 4 million deaths worldwide, in the form of increased risk of cardiopulmonary diseases [1].

With the purpose of protecting air quality and reducing the emission of greenhouse gases, European regulations (EURO) have been put forward, limiting the amount of polluting emissions derived from said forms of transport. In addition, to regulate traffic emissions in real operating conditions, in May 2015, the "Real Driving Emissions" (RDE) procedure was approved as part of the Euro 6 standard legislation. RDE arises from the need to evaluate nitrogen oxides and particulate matter emitted by transport during its circulation on the road. However, although the RDE cycle represents a wide range of driving situations, it excludes certain conditions of real traffic operation, such as engine behaviour at heights above 1200 meters [2].

In line with this, the present work investigates the influence of altitude beyond the boundary conditions established by the standard RDE cycle on particulate emissions, both in terms of their size distribution and of their concentration, utilising a blend gasoline engine stratified with Euro 6 regulations.

The measures were carried out using a Skoda Yeti 1.2 TSI vehicle, which was transformed into a mobile laboratory. This laboratory is designed to obtain the concentration and size distribution of the particles (EEPS-3090, TSI Inc.) and the emission of gases (OBS-2000, HORIBA Ltd.). In addition, it is also equipped with several devices capable of diagnosing the vehicle and determining its position at all times, thus obtaining measurements in real time.

Our tests illustrate that, when the vehicle operates beyond the boundary conditions of the standard RDE cycle, there is a considerable impact on the amount of the polluting emissions. When the altitude increases, we have detected that the EOBD leans the air-fuel ratio due to the oxygen deficit caused by the increase in altitude, which affects the vehicle's emissions. Specifically, in both urban and rural areas, 97% and 47% more total particles are emitted, respectively, as compared to the tests carried out within the limits. In addition, for nitrogen oxides, all the tests carried out beyond the boundary conditions show 17% more of emissions compared to the experiments carried out within the limits.

Our results indicate the need to revise and expand the limits of the RDE cycle since, in the current legislation, operating conditions that are quite common in normal transport work are not considered. Thus, a review of the emission limits set by the standard RDE cycle, at least with respect to the height margins considered, should be the subject of further research.

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Urban and Cold-State Phase Particle Emissions of a Gasoline Hybrid and a CNG Vehicle

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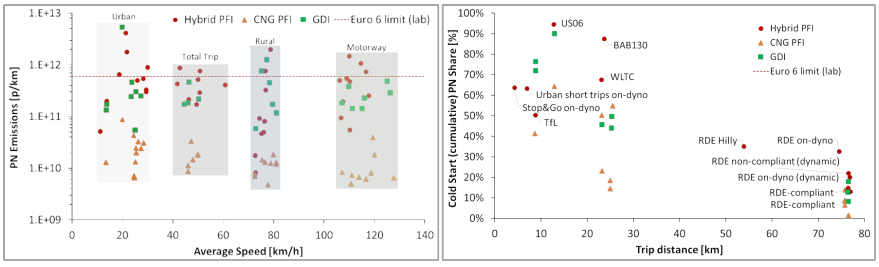
Introduction: Road transport contributes up to 39% to urban $PM_{2.5}$ (11% in EU-28 average) [1, 2], while road vehicles are the biggest contributor to ultrafine particle number (PN) emissions in big cities [3]. EU regulation has addressed light-duty vehicles PN emissions since 2011 for diesel and 2014 for gasoline direct injection (DI) engines. Recent studies show that port fuel injection (PFI) engines are now among the highest emitters [4]. This study evaluates PN emissions of non-PF PFI vehicles over on-road and laboratory tests. The focus is on urban routes and the cold start period, which is not evaluated separately in the current regulation.

Methodology: Two latest-technology vehicles were selected: a EU6d-temp monofuel PFI compressed natural gas (CNG) (tested also as GDI, gasoline is used as backup fuel) and a Eu6d hybrid gasoline PFI one. On-road tests comprised several routes within and beyond the real driving emissions (RDE) boundaries, while laboratory tests included the current type-approval cycle (WLTC) and several urban routes (such as Transport for London). In all tests, PN emissions were measured with a portable emissions measurement system (PEMS), while a prototype sampling system was used for the determination of sub-23nm PN emissions.

Results and conclusions: The graph on the right presents PN emissions of the studied powertrains for the total trip/test and for the urban, rural and motorway parts separately. A wide range of emissions is observed in all vehicles and test phases. This is attributed to the different trip characteristics and driving dynamics of each test. Average CNG PN emissions are more than one order of magnitude lower than the hybrid PFI and the GDI, with no significant difference between the latter ones. Urban PN are on average 2.3 times higher than the total trip PN, revealing the effect of the cold start. The graph on the left presents the cold start (first 5 minutes of engine operation) contribution to total-cycle cumulative PN. The cold start share is up to 95% in short tests, while this is significantly reduced in higher trip distances (up to 30% in typical RDE trips). Among the different powertrains, the lowest cold start contribution is observed in CNG. These findings reveal that cold start period is a major contributor to total-cycle emissions, especially in short trips and can be used to underpin the development of the next emissions regulation towards the suppression of high emitters in urban areas.



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Novel entrained flow SCR using online synthesized catalyst particles in flue gas cleaning systems

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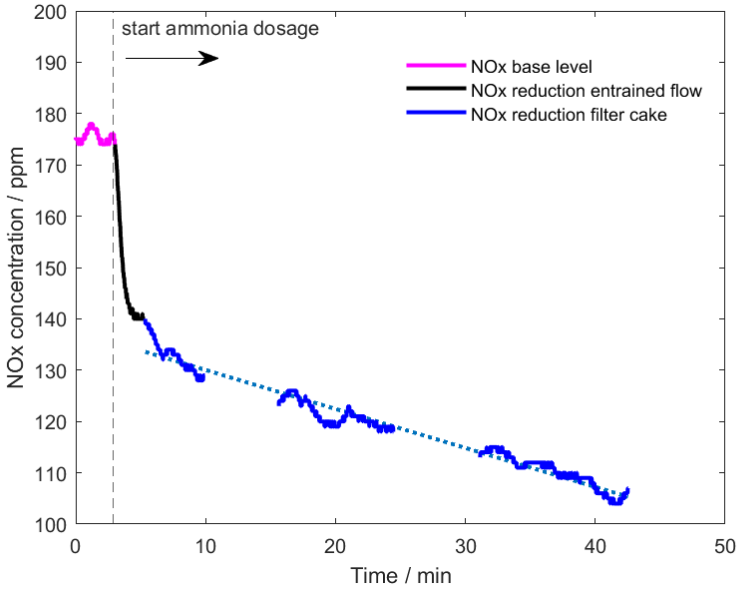
The flue gas of combustion processes – particularly for biomass combustion – typically contains a significant amount of hazardous particles and gas components. Therefore, emission legislation becomes increasingly restrictive regarding these pollutants, particularly NO_x. As an effective upgrade measure for non-compliant processes, selective catalytic reduction (SCR) has become the prevailing technology for flue gas denitrification.

Here, a new concept for integration of a new type of SCR in a compact precipitation system for combustion processes is presented. A surface filter with precoating is used to efficiently precipitate even ultrafine particles without clogging of the filter material. Simultaneously, depending on the precoat material, acid hazardous gases can be absorbed in the precoat layer. The innovative part of this new SCR technique involves the continuous synthesis of catalytically active nanoparticles. The SCR happens in-flight at the freshly created particle surface in the exhaust gas line. Downstream, the catalyst particles are precipitated together with the fly ash particles in the surface filter. Since the nanoparticles are still reactive, the filter cake serves as a fixed bed catalyst and enhances the NO_x separation performance. In contrast to precoat material, the catalyst is not recycled. Hence, the catalysator material is required to be inexpensive. This represents an incentive to replace established catalysators as vanadium oxide by e.g., iron oxide.

The integration of a particle synthesis step into the flue gas results in increased SCR activity and enables either the use of less active metal oxides (as e.g. iron oxide) or the reduction of operation temperature for the SCR. Since low operation temperatures are beneficial for combustion processes coupled with heat recovery, a low-temperature (< 200°C) SCR process was investigated in this work.



First experimental results prove the efficacy of the presented novel SCR concept. Even at very low temperatures (175°C) a noticeable SCR performance was obtained. This concept is a promising approach and has the potential to become an integral part of flue gas cleaning systems with an existing precoat filtration stage.

Reduction of PAHs by the Use of Electrostatic Precipitators at Different Positions in the Exhaust Gas Stream of Logwood Stoves

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Exhaust gas from logwood stoves consists of a wide range of particulate and gaseous pollutants. According to projections of the German Federal Environment Agency (UBA) residential wood combustion is responsible for well over 70 % of polycyclic aromatic hydrocarbons (PAHs) emitted in Germany.

This poster addresses the potential of electrostatic precipitators (ESPs) to reduce PAHs emitted by logwood stoves. The focus is on the influence of the ESP position in the exhaust gas pipe, hence the effect of its working temperature on PAH reduction capability.

The reduction effect towards PAHs of two ESPs at different positions in the exhaust gas pipe was investigated in the public funded research project TeToxBeScheit (funded by German BMEL). ESP 1 was positioned in the hot exhaust gas (average temperature: 300 °C) at the outlet of the stove. ESP2 was positioned 8 m downstream the furnace in the cooled exhaust gas (average temperature: 150 °C). The positions were chosen to simulate different options to integrate an ESP into the exhaust gas pipe under real life conditions.

The results show a significant reduction for all EPA-PAHs with more than 4 benzene rings (starting with fluoranthene) for both ESP positions. The reduction rate for both ESP positions is about 50 % for those PAHs, even though particle characterization shows that PAHs with 4 and 5 benzene rings are not particle-bound under the conditions present at position 1. Thus, these PAHs cannot deposit together with the soot-particles, but still they are reduced. That finding was unexpected and bears some importance for the industry, as ESP integrated into the stove-construction are more marketable than those positioned at the chimney. 3 potential mechanisms leading to non-particle-bound-PAH reduction are presented in this poster.

Another sub-project of TeToxBeScheit investigates the effects of emission reduction through ESPs and catalysts on a toxicological level. The results shall be presented by Manuel Garcia-Käufer from the Institute for Infection Prevention and Hospital Epidemiology (IUK) at University Medical Center Freiburg in a second virtual poster.

Enhancement in Performance Parameters and Reduction in Exhaust Emissions of a Compression Ignition Engine using Stable Nanofuel Suspension

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Particulate Matter emissions from motorized vehicles are of great concern due to their significant health impacts. Upgradation of fuel quality to reduce harmful emissions and accurate measurement of these emissions has become essential. The nanoparticles (like aluminium oxide, cerium oxide, etc.), when added to the base fuel (diesel/gasoline), improve the combustion, performance, and emission characteristics of the fuel[1–3]. Although multiple investigations have reported the impact of nanoparticle additives in improving the particulate emissions from exhaust, very few studies have discussed the impact of stability of the nanofluid fuels[4–6]. The long-term stability of the nanofuel suspension can be enhanced using surfactants as well as by employing mechanical methods to reduce the particle size distribution of the nanoparticles added to the fuel. We have used alumina (Al_2O_3) nanoparticles blended with diesel to test the effects on the emission and combustion characteristics. Simultaneously, the stability of these nanofluid fuels is studied using size analysis with the help of a dynamic light scattering (DLS) instrument.

The results revealed an improvement in brake thermal efficiency and brake-specific fuel consumption along with the reduction of hydrocarbon and nitrogen oxides emissions with the addition of 50 ppm and 100 ppm of alumina to the diesel fuel. Additionally, using DLS, it was found that the alumina nanoparticles remained dispersed in diesel with no substantial change in their size distribution, even after a few days when surfactant was used along with the bath-sonication. Thus, the addition of nanoparticles can have a positive impact in improving the combustion and emission characteristics of engines. Efforts are underway to study the effect of additives on the emission of ultrafine particulate matter.

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Systems for the reduction of Combustion Generated Nanoparticles in Heavy Plant Machinery

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Diesel Particulate Matter (DMP) is a major concern in the mining industry. In 2012 IARC (International Agency for Research on Cancer) classified diesel engine exhaust as a group 1 human carcinogen [1], with a specific limit value of 0.05 mg/m^3 measured as elemental carbon. This will come into effect in February 2026 in the underground mining and tunnel construction sectors. Diesel engine exhaust is a primary source of submicron (particles with diameter < 1 mm) mine aerosol [2]. All these issues are leading mining companies to look for different ways to reduce diesel emissions. The main goal of this research is to assess diesel particulate matter reduction after the installation of an emission control system (Proventia NOx Buster and Purifilter), which is based on a combination of Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR) technologies for emissions reduction in heavy diesel plant machinery. The equipment used for sampling was the spectrometer Engine Exhaust Particle Sizer EEPS-3090 (TSI) and the Rotating Disk Thermodiluter 379020A. The study was carried out in an underground mine in Spain in which most of the mining trucks were installed with emission control systems. All the tests were carried out when the trucks had left the mine fully loaded with the mined mineral. Five Volvo BM A20s were tested, one without any emission control system, two trucks with the Proventia NOx-Buster, and two trucks with the Purifilter system. Table 1 shows the concentration particle number measured with the EEPS-3090 in the heavy plant machinery. The Volvo number 6 without any emission control system had the highest concentration of nanoparticles both when idling, or accelerating. The trucks number 7 and number 2 with the Proventia NOxBuster system, and the trucks number 3 and 5 with the Purifilter system reported around ten times fewer nanoparticles than the truck with no emission control system.

Plant machinery	Year	System	Dilution Factor	Nanoparticles concentration (nanoparticles/cm^3)	Engine Speed
Volvo BM A20-nº6	2001	----	49	500.000	Idling
Volvo BM A20-nº6	2001	----	49	4.500.000	Acelerate
Volvo BM A20-nº7	1990	PROVENTIA NOxBuster	49	40.000	Idling
Volvo BM A20-nº2	1990	PROVENTIA NOxBuster	49	75.000	Idling and acelerate
Volvo BM A20-nº2	1990	PROVENTIA NOxBuster	49	50.000	Idling and acelerate
Volvo BM A20-nº3	1991	Purifilter	49	60.000	Idling
Volvo BM A20-nº3	1991	Purifilter	49	1.000.000	Acelerate
Volvo BM A20-nº5	1988	Purifilter	49	56.000	Idling
Volvo BM A20-nº5	1988	Purifilter	49	100.000	Acelerate

Table 1: Nanoparticles emissions in heavy plant machinery

Fig 1: Nanoparticle sampling.

After analyzing data from the nine samples (taken with the same methodology), results show that the systems based on a combination of Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR) technologies are an alternative way to reduce DPM in the underground mining industry, nevertheless, more research needs to be carried out to verify if this emission reduction is enough.

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Determining the contribution of non-combustion sources by the fine PM source apportionment results in Tehran, Iran

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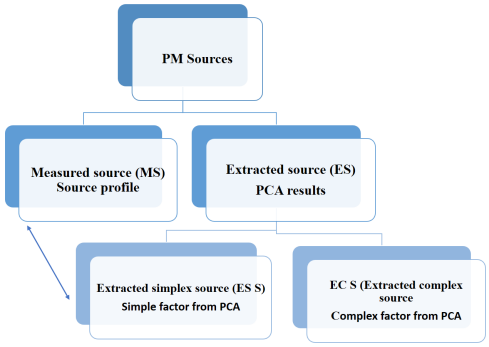
Tehran, the capital of Iran, is one of the most polluted megacities in the world. It is home to over 8 million residents who frequently face episodes of critically high pollutant levels. Fine particulate matter (PM2.5) is one of the most significant criteria air pollutants and frequent episodes of unhealthy air pollution condition have been reported for Tehran, Iran mainly because of critically high levels of fine particulate matter. The composition and sources of these particles are poorly known. The main purpose of this study is to determine the non-combustion sources by developing source apportionment models in Tehran. To do that, the chemical profile of PM2.5 sources were examined and analyzed by principal component analysis (PCA) and chemical mass balance (CMB) models [1,2]. Consecutive use of these models allow us to separate the contribution of PM sources, accurately.



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Inductively Coupled Nitrogen Plasma Mass Spectrometry for online monitoring of metals in airborne particles.

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Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is one of the most sensitive and versatile technology for detection of metals in various sample matrices. In recent years ICP-MS has become a popular technology for the metal detection in individual (nano-) particles, the so called single-particle ICP-MS (spICP-MS) technology [1]. The power of spICP-MS for single particle analysis is the speed of analysis and the quantitative results. Several 100 particles can be analysed per second. Detection limits for pure spherical metal particles range from

In principle airborne particles could be online measured by argon based ICP-MS. The intolerance of the argon plasma to traces of oxigen in the supply gas requires a gas exchange device to replace the air by argon before feeding the sampled particles into the ICP for analysis [2]. The main limitation and the reason why ICP-MS did not yet find widespread in the analysis of airborne particles is the required constant supply of 15-20 L/min of argon. A standard bottle of 50 L compressed gas at 200 bar pressure lasts for about only a day of measurement which limits the use of this technology outside a lab environment with fixed installed gas infrastructure.

A prototype ICP-TOFMS combining a MICAP plasma source (RADOM corp., Pewaukee, USA) and a Time of Flight MS (TOFMS) (TOFWERK, Thun, Switzerland) offers the possibility to run the plasma on a supply of compressed air or nitrogen [3]. Such gas supply is simpler to sustain in a mobile lab and still provides similar analytical figures of merit as argon based ICP-MS. The TOFMS acquires full mass spectra in microseconds to get quantitative multi-element information from individual particles.

This presentation will introduce the instrument outline of the MICAP-TOFMS prototype with figures of merit and demonstrate the usability of such instrumentation for online monitoring of airborne metal rich particles.

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High-throughput generation of aircraft-like soot

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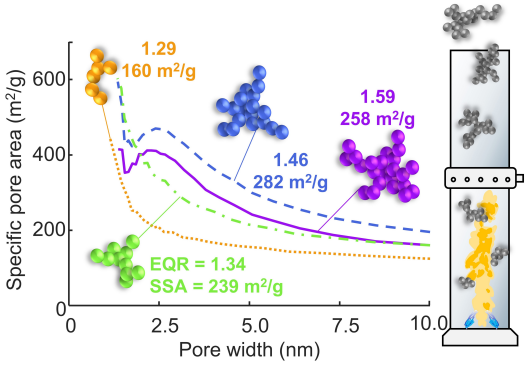
High-throughput, laboratory units for generation of aircraft-like soot are needed to quantify and understand the impact of such emissions on public health and climate change due to the high costs and limited access to aircraft engines. Enclosed spray combustion of jet fuel is used to generate high soot concentrations, up to 255 mg/m^3, three orders of magnitude higher than those typically obtained by widely-used (i.e. miniCAST) soot generators. This enables routine characterization of the soot specific surface area (*SSA*) and pore size distribution (PSD) by N_2 adsorption (Fig. 1) that are of prime importance for assessing the toxicity of nanomaterials [1].



The geometric mean mobility diameter, d_m, of soot agglomerates was systematically varied from 15 to 180 nm by varying the equivalence ratio (EQR) at constant fuel feed rate. The geometric mean primary particle (PP) diameter, d_p, standard deviation, σ_{gp}, and mass-mobility exponent, D_{fm}, were hardly altered in that EQR range. These measured D_{fm} and σ_{gp} indicate that soot PPs were sinter-bonded by surface growth, in agreement with aircraft emissions literature. At these conditions, small agglomerates of soot nanoparticles are emitted having d_m ranging from 11 [2] up to 61 nm [3] and d_p ranging from 10 nm at 50% thrust [2] to 18 nm at maximum thrust (100 %) [4]. The morphology of these agglomerates is quantified by their D_{fm} that ranges from 2.6 to 2.8 at high thrust levels [3]. The organic (OC) to total carbon (TC) mass ratio of soot emitted from high thrust aircraft engines is consistently small (< 20%). Most importantly, soot made at EQR ≤ 1.34 has mainly small pores (Fig. 1) and similar morphology (D_{fm} = 2.52 ± 0.17), *SSA* (160 – 239 m^2/g), OC/TC (< 20 %), d_m (15 – 60 nm) and d_p (14 nm) with those from high thrust (50 – 100 %) aircraft emissions. Thus, enclosed spray combustion units can be used to produce large mass concentrations of aircraft-like soot, enabling the offline characterization of its *SSA* and PSD. Last but probably not least, the *SSA* of soot produced at EQR ≥ 1.46 is enhanced through the presence of pores with 2 – 4 nm width formed by internal oxidation.

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Accurate quantification of Polycyclic Aromatic Compounds (PACs) adsorbed on soot samples

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The incomplete combustion processes contribute to a great extent generating atmospheric pollutants, not only in gas phase but also particles in suspension. The main source of particulate matter in urban areas is traffic [1]. Their emissions are constituted for soot that is mainly composed of black carbon and a soluble organic fraction where organic compounds are adsorbed on it such as Polycyclic Aromatic Compounds (PACs). They are considered as toxic persistent substances [2]. In addition, soot is a strong contribution to the climate change [3].

Nowadays, the mechanism of soot formation is still unknown, although all predictive models agree that PAHs (Polycyclic Aromatic Hydrocarbons) are the key precursors. In this study, two diesel soot (DS) and one biodiesel soot (BS) generated by an engine in the laboratory under controlled conditions were chemically characterised. One of diesel soot (DS-E) sample was generated in a different driving mode than the other two soot samples (DS-G and BS-G). Microwave-assisted extraction (MAE) with two solvent mixtures: acetone:toluene and pyridine:acetic acid were used for the extraction of 28 PACs (PAHs, Nitro-PAHs and Oxy-PAHs) from the soot. The quantification of PACs was performed by using GC-MS/MS operating in Multiple Reaction Monitoring (MRM) mode. This methodology was previously validated with a standard reference material (SRM 1650b) achieving good recoveries for the majority of PACs: 66-183% (acetone:toluene) and 52-183% (pyridine:acetic acid) and total amounts of PACs (ΣPACs) of 699 and 692 ng m^{-1} respectively. The results show higher PACs amounts when using pyridine:acetic acid and these are similar for soot generated in the same driving modes regardless of fuel type (33 and 43 ng m^{-1} for DS-G and BS-G, respectively, and 75 ng m^{-1} for DS-E). However, the recoveries of some internal standards PAHs and NPAHs were < 50 %. A double extraction was carried out obtaining an increase of ΣPACs (74, 73 and 87 ng m^{-1} for DS-G and BS-G and DS-E, respectively and the recoveries were >66 % for all PACs in DS-E. A soxhlet extraction was also carried out for DS-G and the amount of ΣPACs obtained was 422 ng m^{-1}, improving the recoveries (>77%). Therefore, the identification and quantification of certain PACs depend mainly on the conditions of collection and generation of the soot, implying modifications of the extraction conditions.

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Soybean/palm biodiesel soot: characterization and heterogeneous reactivity with NO_2 and CF_3COOH

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Soot is one of the pollutants generated in the incomplete combustion of fuels. Soot contributes to climate change, affect to air quality and has negative effects on the human health. It is important to determine it physical and chemical properties in order to evaluate it impact. The aim of this work is to study the chemical reactivity of biodiesel soybean/palm soot samples, with NO_2 and CF_3COOH using a Knudsen flow reactor, evaluating the initial and steady-state uptake coefficients. Information about the functionalities present on the surface is also obtained since NO_2 is used as a titration agent for reducing or oxidizable groups, while CF_3COOH, a strong acid, is used to evaluate the presence of basic sites on the soot surface. The results indicate that the uptake coefficients obtained for the reaction of NO_2 with soot are one order of magnitude higher than the corresponding for CF_3COOH reaction. The total number of molecules taken up by the soot has also been calculated and the values for CH_3COOH reaction are at least two orders of magnitude higher than the corresponding for NO_2 reactions, indicating the high presence of basic groups on the soot surface. Additionally, functional groups are investigated before and after the reactions using diffuse reflectance infrared spectroscopy (DRIFTS). Bands attributed to C-H bonds in saturated and unsaturated aliphatic chains, C=C vibrations, C-H vibrations in aromatic compounds are present in all samples, and vibrations due to R-NO_2 bonds are also observed in samples treated with NO_2. No clear difference with respect to unreacted samples were found for soot treated with CF_3COOH. Thermogravimetric analysis-differential scanning calorimetry-mass spectrometry (TGA/DSC-MS) has been used to obtain more information about the volatile organic compounds present on the soot and to obtain the mass loss and heat flow profiles in an inert (nitrogen flow) and oxidant (air flow) atmosphere. Finally, information regarding the topography and chemical composition is obtained using scanning electron microscopy (SEM).

Flame Spray Pyrolysis to Asses Sustainable Aviation Fuel Emissions

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Sustainable aviation fuels (SAF) offer advantages to reducing soot emissions and offer possibilities for improving overall aircraft engine performance and fuel efficiency. However, SAF's require extensive testing and evaluation in the development process [1]. Here, the possibility of using a flame spray pyrolysis (FSP) reactor as a tool for rapid screening of soot emissions from liquid fuels is investigated. Liquid fuel is atomized into a spray with dispersion oxygen and ignited by a premixed methane pilot resulting in a turbulent flame with Reynolds numbers ranging from 6216 to 9157. The goal of this work is to assess the day-to-day consistency of the concentration and size distribution of soot particles emitted from FSP to enable using it to compare soot emissions from different liquid fuels. Extensive testing and sampling with Jet A1 were performed to find a benchmark size and number concentration of soot emissions created with FSP and standard jet fuel. An alcohol-to-jet SAF was used for comparison under the same flame conditions. Fuel and dispersion O_2 flow rates were adjusted from 10 mL/min to 12 mL/min and 2.00 L/min to 3.00 L/min respectively, but three flame conditions (fuel [mL/min]/O_2 [L/min]: 10/3.00, 12/2.00, and 12/2.50) were chosen for comparison. Geometric mean mobility diameter (GMD) from Jet A1 ranged from 28 to 111 nm and total number concentrations varied from 1.88×10^6 to 1.53×10^7 #/cm^3. The ATJ GMD and total number concentration sampled were consistently lower, with a range of 19 to 91 nm and 0.67×10^6 to 1.39×10^7 #/cm^3. The GMD geometric standard deviation (GSD) varied between 1.54 and 2.06 for all samples compared. Although turbulent flame sampling is expected to have day-to-day inconsistencies, improvements are being made to reach a goal of <10% variability through day-to-day testing.

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Environmental nanoparticle exposure triggers gammaherpesvirus reactivation via the MAPK signaling pathway in macrophages

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Environmental particle inhalation and persistent herpesvirus infection are omnipresent and associated with chronic lung diseases. Previously, we showed that pulmonary exposure to soot-like carbonaceous nanoparticles (CNP) and fiber-shaped engineered double walled carbon nanotubes (DWCNT) induced an increase of lytic viral protein expression in latently murine gammaherpesvirus-68 (MHV-68) infected mouse lungs, with similar pattern as acute infection suggesting virus reactivation. However, the underlying mechanisms remain unclear.

Mitogen-activated protein kinase (MAPK) signaling, a stress response pathway also activated by certain particle-cell interactions, has been reported to contribute to herpesvirus infection. We therefore studied whether CNP and DWCNT reactivate MHV-68 via MAPK signaling.

In a MHV-68 infected murine model, we confirmed that CNP exposure reactivated herpesvirus mainly localized to CD11b+ infiltrating macrophage-like cells. To study the underlying mechanism, we exposed persistently MHV-68 infected bone marrow derived macrophages (Ana-1/MHV-68) with CNP and DWCNT. MAPK signaling and transcriptomic changes were investigated. Here, we found that ERK1/2, JNK and p38 MAPK were rapidly activated within the first hour after CNP and DWCNT exposure, followed by upregulation of viral gene expression (24 h) and increased viral titer (72 h). However, no pro-inflammatory transcriptional signature was detected within 3 & 9 h. Further pharmacological inhibition of p38 activation abrogated CNP but not DWCNT triggered virus reactivation. *In vivo,* immunohistochemistry staining showed that p38 inhibitor pretreatment in latently infected mice attenuates MHV-68 reactivation induced by CNP exposure.

Our findings suggest that CNP activates latent herpesvirus via p38 MAPK signaling, and that pharmacological inhibition might alleviate ambient particle exposure related disease exacerbations.

Particle effective densities and size distributions in vehicular and wood combustion exhaust emissions: Implications to particle deposition in the human respiratory system

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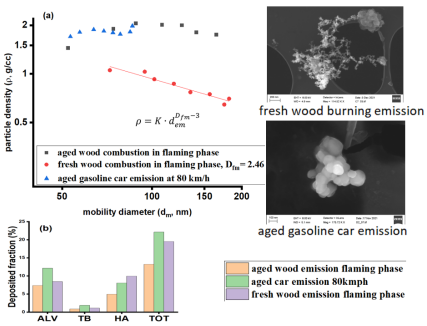
Size, morphology, and composition of airborne particles strongly affect human health. In this study, the size distribution and effective density of fresh and aged fine particulate emissions from small-scale combustions were measured using tandem aerosol particle mass analyser and scanning mobility particle sizer (APM-SMPS) system. A SKODA SCALA (EURO6 gasoline car equipped with particle filter) on a dynamometer was operated in four consecutive cycles consisting of cold and warm idling and three distinct velocity phases with successive accelerations and decelerations, to study vehicular particle emissions. For wood combustion emissions beech logs were burned in a modern chimney stove, of which particles of four separate combustion phases, namely warm and cold ignition, flaming and ember phase, were studied separately. The emissions were photochemically aged using the oxidation flow reactor *PEAR* (1). The ICRP lung deposition model was applied on all the available particle size distribution and effective density data to estimate the relative fraction as well as the total mass deposition of these fine particles in head airways (HB), trachea-bronchial (TB) and alveolar (ALV) regions, which were then used to approximate the exposure levels.



Particles of photochemically aged vehicular emissions were significantly smaller (geometric mean diameter 38-62 nm) than that of wood combustion aerosol (geometric mean diameter 69-250 nm). Particle size distribution differed from idle and driving stages but the extent of OH exposure did not seem to have any major effect on size and effective density. For wood combustion, ageing conditions and combustion phases had significant effect on particle size, shape and effective density (Figure 1a). The modelled lung deposition estimates indicate that relative mass deposition and exposure of photochemically aged car emission particles are highest in the alveolar (ALV) region of the lungs, whereas fresh wood combustion particles dominate depositions in the head airways (HA) region (Figure 1b). This work shows that photochemical aging substantially changes the effective densities and morphologies of combustion-derived particles with implications to lung deposition estimates and ultimately to human health.

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Health Impact of inhaled log wood stove emissions by means of advanced *in-vitro* Exposure Systems based on the Air-Liquid Interface Technique - a tool for assessing the performance of emission mitigation measures at the biological effect level

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Background: During the wintertime, residential wood smoke is a main contributor to fine particle pollution (PM) and is co-responsible for poor air quality. However, the assessment of adverse effects after inhalation of wood smoke has so far mostly focused on the impact attributed to the solid particulate fraction, whereas volatile compounds have been frequently neglected or at least underestimated. Some of these chemicals that are released into the air are however toxic, some irritate the respiratory tract, affecting the immune system, and some may cause cancer when inhaled. Wood smoke is a higly complex and variable mixture of compounds and particulates difficult to be approached in a comprehensive way, especially when it comes to health risk assessment. This is probably due to the expense involved in toxicological characterisation because it demands an interdisciplinary approach, including combustion process technologies, physical-chemical analyses, and finally, biological hazard assessment. State-of-the-art in-vitro toxicological evaluation strategies have currently reached an acceptable scope of application but still a poor regulatory consideration. Meanwhile, advanced in-vitro exposure systems are able to close the gap, linking aerosol formation and exposure events both temporally and spatially and can be used to point out to what extent practical technical emission reduction measures (i.e. catalyst, electrostatic precipitator) can be made visible by cell-based bioassays.
Methods: Sensitive human cell cultures, representing the lower respiratory tract epithelia (A549 alveolar cell line), were grown and exposed to wood smoke at the air-liquid-interface (ALI) aiming to approach a realistic scenario. Whole wood combustion aerosol (quasi-native) as well as aqueous aerosol condensates (impinger sampling) were examined for their relative toxicity potential using *online* and *offline* exposure settings respectively, and followed by molecular bioassays. Lung cells were exposed against whole wood smoke by means of an Automated ALI-Exposure-System (Vitrocell®), being this data complemented by traditional submerged exposure settings in order to increase significance and relevance. Appropriate toxicological endpoints were adressed and parameters for cytotoxicity, inflammation, and genotoxicity were analysed in dependence to different firing operation conditions: untreated raw aerosol, catalyst and electrostatic precipitator.
Results: A tiered assessment strategy ending with a bioassay battery is able to reveal the health impact of inhaled whole wood smoke. Moreover, emission-reducing technical measures could be quantified considering acute exposure scenarios. The data illustrate the effectiveness of technical measures by reducing PM load and organic compounds. While raw combustion aerosol shows the highest cell-damaging potential, the implementation of a catalyst, also in combination with an electrostatic precipitator, results in a significant reduction in toxicity.
Conclusions: Being part of a interdisciplinary study, comprehensive monitoring of combustion processes and characterisation of emissions using toxicological approaches can expand the knowledge regarding the potential effects that wood combustion aerosol exert on human health. Advanced in-vitro exposure systems have been proven to enable for a better prediction of acute toxicity, aiming to provide a valuable tool to estimate safety of log wood stoves and biomass combustion processes in general. The work moreover illustrates and reinforces the increasing performance of alternative methods to animal testing in toxicology (3Rs).

The efficiency of mobile air purifiers in private homes

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Candles, cooking, wood burning, and smoking as well as degassing from furniture and other consumer products are important pollution sources of ultrafine particles (UFP), fine particles ($PM_{2.5}$), and volatile organic compounds (VOCs) in indoor environments. Likewise, outdoor air pollution may cause unhealthy indoor environments. The long-term solution is to avoid air pollution. In the short-term, mechanical ventilation and frequent airing might reduce indoor air pollution if the outdoor air is clean. However, this is not always the case. Consequently, an increasing number of citizens and institutions buy mobile air purifiers. Different products using different purifying technologies are available. However, purifiers are approved on a laboratory base and only a few detailed test studies have been performed in private homes and compared with the efficiency of extractor hood, manual airing, and mechanical ventilation. **Purpose:** To test air purifiers (found efficient in laboratory tests) in private homes and to compare the results to the laboratory results, the purifier product information (promised efficiency), and the efficiency of an extractor hood, manual airing, and mechanical ventilation. **Methods:** Eight mobile air purifiers using different technologies were found efficient in laboratory tests (other ETH submission). These purifiers were tested in a private home in A) A large living room openly connected to a kitchen-dining area with vaulted ceiling having a total volume of 192.5 m^3, and B) Three connected rooms without vaulted ceiling (bedroom, walk-in closet, and bathroom) having a total volume of 67,5 m^3. The air purifiers were individually tested for their ability to remove UFP, $PM_{2.5}$ and VOCs generated from frying bacon in the kitchen and using scented candles in the bedroom, respectively. UFPs were measured with newly calibrated P-Traks from TSI, $PM_{2.5}$ was measured with newly calibrated DustTrak DRX from TSI Inc, and VOCs were measured with a newly calibrated Tiger TVOC Detector from ION Science. The efficiency of the purifiers was compared with manual airing (opening just one window and opening several windows creating a draft through the rooms), using extractor hood in the kitchen (on highest and second-highest level), and mechanical ventilation on low, medium, and high level. **Results/Discussion:** Tests will be performed in the first week of May. Hence, the results/poster will be ready well ahead of the ETH-conference on Combustion Generated Nanoparticles. The results of the mobile air purifiers will be compared with the results attained in the laboratory tests, purifier product information (promised efficiency), and the efficiency of manual airing, extractor hood, and mechanical ventilation. **Acknowledgement:** These experiments have only been possible due to the financial support of Realdania Foundation and The Danish Landowners' Investment Foundation (Danish: Grundejernes Investeringsfond). **Main author:** Kaare Press-Kristensen holds a master's and a Ph.D. in environmental engineering from the Technical University of Denmark. He has been teaching air pollution for 20 years at the university (recent years as external). He works as senior air quality advisor in Green Transition Denmark. His work is focused on indoor pollution sources and wood burning, road traffic, shipping, non-road machinery, and aircrafts. He works with emissions, ambient air quality, and the connected risk to public and occupational health. He mainly works on an international level. Contact info: kaare@rgo.dk / (+45) 22 81 10 27.

Distribution, size segregation, sources of indoor particulate matter during burning ofmosquito coils and incense sticks emissions and their health impacts

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Indoor combustion source, like incenses, are commonly used for aesthetic and religious purposes in various indoor as well as outdoor environments. The combustion leads to the production of a large amount of smoke, which can pose a health risk due to inhalation exposure of particulate matter (PM). Burning of mosquito coil and Incense sticks, is currently used in numerous households in Asia, Africa, and South America. However, thesmoke may contain pollutants of health concern. The indoor air pollution during household's combustion of solid fuels in developing countries causes several health problems. The health problems related to indoor aerosol increases the risk of tuberculosis, asthma, cataracts, low birth weight, peri-natal mortality, etc. Hence, in this work, segregation of particulate matter in 8modes i.e. $PM_{10.0-9.0}$, $PM_{9.0-5.8}$, $PM_{5.8-4.7}$, $PM_{4.7-3.3}$, $PM_{3.3-2.1}$, $PM_{2.1-1.1}$, $PM_{1.1-0.7}$ and $PM_{0.7-0.4}$.The mean concentration of black carbon (BC), organic carbon(OC), total carbon (TC) and PAHs in the mosquito coils and incense sticks emission with the range of 16255±229, 142052±1684, 158307±1734, 22839±390 and 6602±262, 63902±1478, 70504±1674, 15196±105 respectively. The concentration of ions i.e. F^-, Cl^-, SO_4^{2-}, NO_3^-, NH_4^+, Na^+, K^+, Mg^{2+}, $Ca^{2+}$was ranged from 75–190, 125–375, 210–475, 75–202, 25–90, 80–175 and 440–905,375–595, 975–1226 mg kg^{-1} with mean value of 954±25, 1680±59, 2778±59, 1019±25, 421±14,1034±22 and 5830±111, 3764±53, 8805±70 $mgkg^{-1}$, respectively. The source apportionment for mosquito coil and incense sticks burning contributes from different sources. The findings from the present study suggest that exposure to the smoke of mosquito coils and incense sticks similar to the tested ones can pose significant acute and chronic health risks.

Influence of the combustion phase on the physico-chemical properties of particulate matter

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Introduction & Background: The World Health Organization (WHO) has classified air pollution as the biggest health risk of the 21st century [1]. One of the major sources of air pollution with both local and global dimensions is biomass combustion. In urban environments, emissions from small combustion plants often make a major contribution to fine particulate air pollution. The potential hazard of inhaled particulate matter (PM) depends on its chemical composition, shape and size. These characteristics influence their deposition in the respiratory system and their subsequent potential toxicity. The main objective of this work was to verify the influence of the combustion phases of wood in a small stove on the particle composition, and also to verify a possible correlation between particle size and particle composition

Methodology: The combustion tests were carried out on a manual log feed stove from the Czech manufacturer ABX, model Grönland, specially adapted for experimental purposes. In this device, beechwood without bark with a moisture content of about 6,1 % was burnt. The weight of wood added per cycle was 2 kg. Sampling was carried out isokinetic using a 14-stages low-pressure impactor Dekati® HT-DLPI+. The deposited polycarbonate filters with a diameter of 25 mm and without pores were analysed on an electron microscope (LYRA 3, Tescan) with EDX.

Results & Conclusion: The combustion process was divided into two phases, the first phase is the combustion of volatile matter and the second phase is char burning. The first combustion phase is characterised by the solid deposit of PM being made up of primary spherical to oval particles of about 45-80 nm in size, which are further agglomerated into spatial secondary particles. In terms of topography, the samples are very similar. In the second phase, there is a visible difference between the samples correlating with increasing fraction size. The primary particles are spherical, regular, mostly with a narrow size distribution curve within a given sample and a tendency to form agglomerates. In the case of larger fractions (size range from 2 µm to 10 µm), these agglomerates are irregular. The smaller fractions show a clear tendency to form regular larger spherical agglomerates, usually up to 1 µm in size. This topographical change of the PM during combustion is not yet clarified. Furthermore, the dependence of particle composition and size was investigated. In both cases, the particles are mainly composed of carbon and oxygen atoms. In the case of particles from the first combustion phase, in addition to carbon and oxygen, potassium, chlorine, and a small amount of sulphur. Size does not affect the composition in any way; all particles show similar trends. In the case of samples from the second phase of combustion, the relationship between size fractions and composition is visible. In the case of oxygen and carbon content, the opposite trend is visible - while the carbon content increases with increasing size (increasing from 40 % by weight to 88 %), the oxygen content decreases. For the smaller fractions, an increase in potassium and sulphur content is visible and zinc also appears. Interestingly, there is a significant change in the potassium content, with the 0.05-0.09 µm size fraction having a concentration 16× higher than the 0.9-1.6 µm size fraction.

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Controlling the Sampling Parameters to quench Collision Growth of Soot Particles extracted from Laminar Premixed Flames

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The purpose of this study is to investigate the effect of the sampling parameters on the size distribution function (SDF) of naturally and collision-charged particles extracted from a laminar premixed flame. The ability to quench the sampling-induced modifications of the results would contribute to a deeper understanding of gas to particle conversion. Sampling was performed by applying a constant suction pressure into a set of tubular probes each equipped with a small orifice drilled through its wall to extract the soot particles from the flame. The soot particle nuclei are diluted with nitrogen and conveyed to a Half-Mini High-Resolution Differential Mobility Analyzer (DMA) after getting charged by colliding either only with the ions from the flame or also with the ions seeded by radioactive decays in the dilution nitrogen. The transport and charging residence time, Δt, from the sampling orifice to the DMA inlet is controlled by modifying the flow pattern toward the DMA so that its effect on the measurements is isolated by keeping constant other sampling parameters. Similarly, the effect of the orifice diameter size (i.e., the dilution ratio, DR) is isolated as well. For both the naturally and collision-charged nanoparticles, the results indicate that the shape of the measured SDFs can be made independent of Δt only when it is smaller than 40ms and for sufficiently large dilutions. Nonetheless, the achievement of sampling independent results for the smallest particle nuclei becomes progressively more challenging as the total particle load increases at progressively further downstream sampling positions in the flame.

A critical evaluation of failures in current air pollution control policies in India and proposal of innovative future policy perspectives.

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India in general and Delhi in particular have become the air pollution hotspot and capital of the world after being consistently ranked among the top air polluted countries and cities globally [1]. Air pollution is a big cause of morbidity and mortality world over [2, 3, 4]. The current and recently introduced schemes and policies to arrest air pollution in India and specifically Delhi and adjoining areas have been futile. These include failure and subsequent dissolution of Environment Pollution (Prevention & Control) Authority (EPCA), ineffectiveness of Green Tribunal formed in 2010, intermittent odd-even schemes (since 2016) of managing vehicles on roads, non-utilization of Graded Response Action Plan (GRAP) for arresting pollution since 2017, negligible output in pollution remediation since installation of multiple smog towers, non-implementation of fines on stubble burning, ground level non-functionality of Commission on Air Quality Management (CAQM) in the National Capital Region (NCR) and adjoining areas (2020), failures of 1st and 2nd Industrial Policies (1982 and 2010-2021) for Delhi, etc. The methodology in this paper includes an extensive literature review to critically evaluate the current air pollution control policies in India and propose innovative future policy perspectives to better manage the air pollution scenario. Comparison of policies of various countries and cities especially with similar demographic and geographic backgrounds as India and Delhi has been done. It is expected that this research will aid the policy makers to fine tune the gaps and issues in current policies and adopt some of the recommendations offered in this research to evolve a robust and scientifically sound policy for air pollution remediation in India.

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On the toxicological effects of primary vs secondary aerosols: implication for human health

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Air pollution is the first cause of death among the environmental related issues and despite the efforts in reducing the concentration of airborne particulate matter (PM) pollution, epidemiological evidences still show significant association between exposure to fine PM (PM2.5) and mortality/morbidity. Notably, significant association is now reported for mass concentrations previously considered as safe [2]. Toxicologists have now pointed out the relevance of sub-micrometric particles well below the 2.5 and 1 µm thresholds that are considered in current international legislations. Despite the accumulating evidences [1, 2], the actual metrics used for air quality evaluation and health protection are based on the mass concentration metric while, for example, standards for vehicle emission classification (such as EURO-6) consider the particle number concentration of ultrafine particles (particles with diameter< 100 nm, UFP) as metric. The RHAPS project [3]. had among major objectives to identify specific properties of the fine PM from combustion sources that are responsible for toxicological effects and can be used as new metrics for health-related outdoor pollution. Toxicological tests were performed by exposing at the air liquid interface (ALI) directly at the site of air pollution monitoring the bronchial epithelial BEAS-2B cells for 24 hours consecutively. The following genes were analyzed by real time PCR in exposed and control cells: HO-1 and NQO1 for oxidative stress responses, ATM and GADD45a for DNA damage and IL-8 for inflammation. IL-8 protein release was also analyzed. Doses of exposure were defined according to [4]. Significant increases of oxidative stress (HO1 and NQO1) and inflammatory (IL-8) signals were observed mainly in winter days while DNA damage signals increased both in summer and in winter. The oxidative responses were selected as proxy of overall damage and correlated to the mass concentration metric of PM1 and UFP showing a low significance (R^2 below 0,05). We explored the possibility to correlate the biological outcomes with other metrics. Interestingly, the higher correlation was found between oxidative response and number deposition of particles for both PM1 and UFP although the overall correlation remained low (R^2 = 0.24). The correlation improved when considering particles with diameter below 50 nm (R^2 = 0,271) and this correlation increased when cutting the upper diameter at 45 nm (R^2 = 0,276). Interestingly, the correlation further increased when considering the fractional numbers over the total UFP fraction (R^2 equal to 0,299 and 0,349 for 50 and 45 nm particles, respectively), therefore accounting for the relevance of primary emitted particles. Preliminary observation also showed that the fractional content of black carbon (fBC) may explain part of the response variability, additional analyses are ongoing in this sense. The results obtained clearly show that the mass concentration and mass dose of exposure are metrics that are not able to catch the toxicological potency of urban air pollution. The correlation obtained between UFP and oxidative response point out the importance of primary combustion nanoparticles in driving the biological outcomes, this sustained by the association of BC with the size of UFP. In conclusion the results sustain i) the relative lower importance of secondary particles in generating oxidative responses in exposed cells and ii) the urgent need of revising the air quality metrics in force at national and international level, taking into account the importance of UFP (or fraction of) particles and the content of BC.

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Effects of Traffic-Related Nanoparticles in the animal model *C. elegans*: Neurodegeneration and Neurodegenerative Diseases

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style="text-align: justify;">How the environment contributes to neurodegenerative diseases such as Alzheimer's is not well understood. In recent years, science has found augmenting evidence that nano-sized particles generated by transport (e.g., fuel combustion, tire wear and brake wear) may promote Alzheimer's disease (AD) and Parkinson's disease (PD). Individuals residing close to busy roads are at higher risk of developing AD, and nanomaterials that are specifically generated by traffic-related processes have been detected in human brains. The invertebrate nematode *Caenorhabditis elegans* (*C. elegans*) was chosen as a model organism to investigate neurodegenerative bio-interactions of silica nanoparticles (NPs). *C. elegans* shares 60-80 % gene homology with human genes, including disease genes. Thus, we are elucidating the effects of traffic-related NPs on AD and PD models, and thereby their possible effects on human health. Additionally, we include the non-chemical factor temperature into our analyses as little is known about the interactions between the biological response to traffic-related NPs, climate change and an aging population.

Age-synchronized *C. elegans* are treated and kept in liquid culture on 96 well plates where each well represents a specific microenvironment. Observations of the worm behavior after treatment provided us with information about the balance of the organism's protein set and the status of the neuronal network. Single neurons and their function were observed via reporter worms to visualize, quantify and correlate neurodegeneration to previously discovered NP-related behavioral phenotypes. Furthermore, mass spectrometry-based studies of the proteome provided insight into gene expression and affected cellular pathways. We also developed age-resolved locomotion tests to assess age-specific vulnerabilities and behavioral phenotypes under different environmental conditions. As non-chemical environmental factor we include cultivation temperatures between 15 and 25° Celsius to interrogate the contribution of climate to the biological responses against traffic-related particles.

Silica NPs caused widespread protein aggregation correlated with premature aging phenotypes. Age-associated phenotypes included reduction of pharyngeal pumping, disorganization of gut morphology, and reduced locomotion fitness. Accelerated aging additionally manifested in premature neurodegeneration (i.e. impaired serotonergic neurosignaling), specifically in the hermaphrodite specific motor neuron (HSN) which caused reproductive defects. Large-scale studies of the proteome identified the gene ontology group "protein folding, proteolysis and stress response" as major target of silica NPs. Neuromuscular defects such as reduction of locomotion and paralysis were observed. The conclusion is that silica NPs cause premature aging in *C. elegans* driven by an imbalance of protein homeostasis. In order to bridge the results to human health, we currently are investigating the effects of silica NPs in *C. elegans* models of AD and PD, which include human copies of tau protein or amyloid-β peptides (i.e. AD models) as well as α-synuclein (i.e. PD model).

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Gaseous and particulate inorganic reactive nitrogen (Nr) species at an agriculturally intensive rural site of Delhi – NCR

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The world's acute reactive nitrogen (Nr) pollution is chronically eroding the biospheric integrity and undermining the earth system's resilience to be in an accommodatable state. Owing to this precariousness of Nr pollution, it becomes imperative to study the abundance and distribution of Nr species, especially in the hotspots of Nr pollution. Therefore, the present study reports simultaneous measurements of inorganic Nr trace gases (NH_3, NO_2, HNO_3) and the corresponding particulates (pNH_4^+, pNO_3^-) at an agriculturally intensive rural site in Delhi-NCR. The samples were (n=60) collected from October 2017 to September 2018. The annual mean (± standard error) concentrations of NH_3, NO_2, pNH_4^+, and pNO_3^- were observed to be 99.20 ± 7.55, 26.26 ± 1.55, 9.99 ± 2.78 and 14.48 ± 1.55, respectively. HNO_3, on the other hand, was observed to be below the analytical detection limit during the entire study period, which could be attributed to the alkaline-dust-rich atmosphere of the study domain. The seasonal gradients in the mean concentrations of NH_3, pNH_4^+, NO_2 and pNO_3^- were observed as post-monsoon > winter > pre-monsoon > monsoon. To depict the transformational extent of NH_3 and NO_2 (to NH_4^+ and NO_3^-, respectively). The conversion ratio of ammonium (NHR) and nitrate oxidation ratio (NOR) were calculated separately for all seasons. Results showed lower magnitudes of NHR and NOR which are attributable to the lower transformation of NH_3 and NO_2 to NH_4^+ and NO_3^-, respectively. Backward wind trajectories computed with the help of HYSPLIT transport and dispersion model revealed that arriving air masses at the sampling site during the sampling period were originated from both regional and transboundary source regions.

Keywords: Seasonal variability, Reactive nitrogen, Long-range transport, Gas-to-particle conversion

Assessment of personal exposure to black carbon pollution level in an urban area

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Nowadays, cities cover 2% of the world's land area and account for 60% of total greenhouse gas and other emissions [1]. Enhancing air quality should lead to an improvement in public health due to the reduction in the health effects associated with particulate matter pollution.

Black Carbon (BC) particles are formed during the combustion of fossil fuels and solid biofuels and are around 200 nm in diameter [2]. Due to the small radius BC particles can reach the alveolar region, penetrate the circulatory system, and reach further internal organs [3]. Lately, due to the rapidly growing transportation sector, transport-related pollution is the prevailing BC source in developed cities and is a major problem for ambient air quality there. Air quality monitoring stations represent the general pollutant levels prevailing in the selected area but cannot reflect the personal exposure while travelling in the city. In this study, we examined changes in the urban air quality, i.e., fluctuations in the black carbon mass concentration experienced during walking, cycling and travelling by car in Vilnius and the contribution of pollution sources.

In the present study, a modern micro-Aethalometer (AethLabs, MA200) was used to measure the BC mass concentration and to determine the level of pollution in mobile mode on the road while travelling by car and on foot in different urban environments. In order to determine personal exposure for a passenger in a car, the BC mass concentration measurements were conducted inside and outside the vehicle. Results of mobile measurements were compared with urban background level evaluated by stationary continuous measurements of aerosol BC performed using a 7-wavelength Aethalometer (Magee Scientific, EA31) in the urban background environment.

Assessment of the spatial distribution of BC pollution revealed that the impact on cyclists and pedestrians is up to 16.6 times higher than in the background urban environment. Meanwhile, when travelling by car, the BC exposure inside the car is 2 times higher than in the urban background environment. Although the BC mass concentration is reduced by 70% inside the car compared to the on-the-street level. BC mass concentration results were visualized using GIS software to represent the spatial distribution of BC pollution. The results of the study raise major concerns and present important evidence for sustainable urban planning and alternative route selection.

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Brown-black carbon aerosol ambient sources, absorption properties and optical interactions

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Understanding the sources of light-absorbing organic (brown) carbon (BrC) and its interaction with black carbon (BC) and other non-refractory particulate matter (NR-PM) fractions is important for reducing uncertainties in the aerosol direct radiative forcing [1]. Here, multiple filter-based techniques are combined to achieve long-term, spectrally resolved, source- and species-specific atmospheric absorption closure.

Specifically, the mass absorption efficiency in dilute bulk solutions [2] at 370 nm is found to be equal to 1.4 m^2 g^{-1} for fresh biomass smoke, 0.7 m^2 g^{-1} for winter-oxygenated organic aerosol (OA), and 0.13 m^2 g^{-1} for other less absorbing OA. Mie calculations are utilized to estimate the contributions of these fractions to total aerosol absorption. While enhanced absorption in the near-UV is often attributed to primary biomass smoke, here we show that anthropogenic oxygenated OA may be equally important for BrC absorption during winter, especially at an urban background site (Zurich).

Further, the mass absorption cross-section (MAC) of BC is assessed to be largely independent of its source, while evidence is provided for a filter-based absorption enhancement (lensing) effect associated with NR-PM components. The analysis results reveal that bare BC has a long-term MAC of 6.3 m^2 g^{-1} at 660 nm and an absorption Ångström exponent of 0.93 ± 0.16, while in the presence of coatings its absorption is enhanced by a factor of 1.4. An indication for suppression of the filter-based lensing effect in the presence of BrC is provided, based on Mie calculations of closure between observed and predicted total light absorption. The total absorption reduction remains modest, 10–20 % at 370 nm where BrC absorption is significant.

Overall, the presented results [3] allow an assessment of the relative importance of the different aerosol fractions to the total absorption for aerosols from a wide range of sources and atmospheric ages. When integrated with the solar spectrum at 300–900 nm, bare BC is found to contribute around two-thirds of the solar radiation absorption by total carbonaceous aerosols, amplified by the filter-based lensing effect (with an interquartile range, IQR, of 8–27 %), while the IQR of the contributions by particulate BrC is 6–13 % (13–20 % in Magadino, a rural Swiss site, during winter).

Future studies that will directly benefit from these results include (a) optical modelling aiming at understanding the absorption profiles of a complex aerosol composed of BrC, BC and lensing-inducing coatings; (b) source apportionment aiming at understanding the sources of BC and BrC from the aerosol absorption profiles; (c) global modelling aiming at quantifying the most important aerosol absorbers.

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Alteration of single scattering albedo during high pollution event in Vilnius, Lithuania

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Aerosols play a crucial role in atmospheric radiative budget because of their ability to scatter and absorb light. Ability to warm or cool the atmosphere depends on various parameters such as optical properties, chemical composition, particle size, aging and other atmospheric processes. Complex field observational studies of aerosol properties under real and various conditions are crucial for reducing uncertainties in estimation of aerosol radiative forcing. In this study, an event of high air pollution levels was investigated with an aim to understand drivers of single scattering albedo (SSA) alterations. Complex measurements and investigation of aerosol chemical composition, microphysical and optical characteristics were conducted in urban environment in Lithuania during residential heating season (from 10th October to 1st November 2014). Brown carbon analysis revealed that residential biomass burning and primary traffic-related OA (BBOA and POA, respectively) exhibited higher mass absorption cross-section values (1.14 m^2 g^{-1} and 1.68 m^2 g^{-1}, respectively). During the measurement campaign, an extreme pollution event appeared which was investigated by dividing it into two parts. During the first part of the event PM_{10} (HC1) mass concentration reached up to 156.7 µg m^{-3}. SSA did not show any significant changes and the value of 0.95 remained. Meantime, at the second part of event (HC2), another peak of PM_{10} was registered (90.3 µg m^{-3}) which resulted in lower SSA value (0.86). A strong correlation between SSA and PM_1/BC was found for all the event (r=0.82).

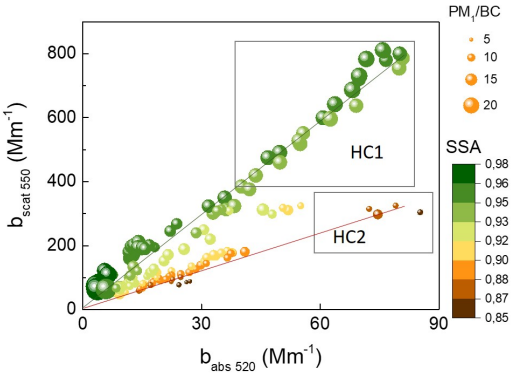

Fig 1. b_{scat} dependence on b_{abs} together with PM_1/BC (as data points size) and SSA (as colour scale). Two squares are showing data points which occurred during HC1 and HC2 episodes.

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Performance of the new PN-PEMS instrument MPEC+ and comparison of real driving emission between cold and warm engine for a fleet of EURO 5 and Euro 6 vehicles

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Object of this study was to study the performance of the new PN-PEMS instrument called MPEC+ (Dekati Ltd.) and then use the MPEC+ to study how engine conditioning affects the real driving particulate emissions. The core of the MPEC+ is the Dekati's recently introduced ePNC sensor [1] which is based on diffusion charging technology and has already demonstrated its performance on engine idle and auxiliary heater measurements [2]. MPEC+ fulfills the counting efficiency requirements defined by EU regulation 2017/1154 [3] with $d_{50\%}$ at 23 nm.

To test MPEC+ performance, a diesel vehicle was driven according to Worldwide Harmonized Light Vehicles Test Cycle (WLTC) on a chassis dynamometer. Reference instrument was a CPC (Airmodus A23) that was placed after a constant volume sampler and an additional dilution combined with an evaporation chamber. The MPEC+ was found to be in good agreement with the reference PMP-system.

A fleet of gasoline and diesel passenger cars solid particle number (SPN) emissions were measured using the MPEC+. Vehicle ages ranged from 2009 to 2022 and hence all vehicles fulfilled EURO 5 or EURO 6 standards. Focus of the measurement campaign was to evaluate the effect of engine condition to real drive SPN in cold northern conditions. Measurements were carried out in Finland in Tampere region. Length of the route was approximately 23 km and contained diversely different road types from urban to highway. All vehicles drove the same route twice, first with cold engine and then under normal engine running temperature. Temperature conditions during the campaign where close to zero degrees and vehicles were left to cool down at least for 4 hours, before the cold driving cycle.

It was observed that, as diesel engines with fully operational DPF doesn't emit particles, gasoline engines produce significant particle number emissions especially after cold start. Also, hybrid vehicles were tested. Hybrids change the source of power between electricity and combustion frequently depending on the driving condition. These multiple starts lead to different emissions during the drive cycle, compared to normal internal combustion engine using vehicles.

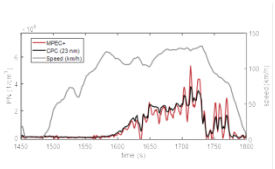

Figure 1. Performance of the MPEC+ against a PMP-type reference

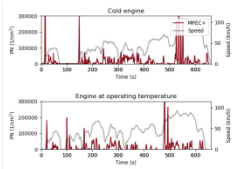

Figure 2. Comparison of SPN between cold engine and engine at operating temperature

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A suitable aerosol generator for infield-calibration of particle number devices for PTI and low-cost black carbon absorption photometers

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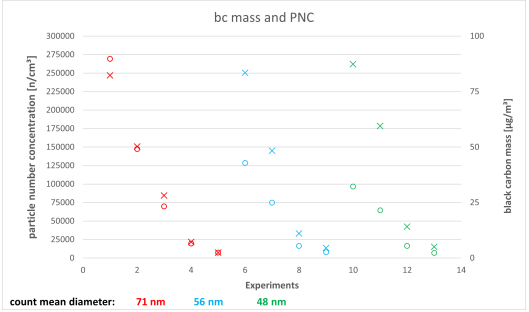
Introduction & Background: Particulate number emissions from road vehicles are in the focus of the current PTI legislation in Germany. Therefore, the PTI PN device must be approved and calibrated, specifically three technical procedures have to be fulfilled [1,2,3]. In parallel, absorption photometers are commonly used to measure the atmospheric mass concentration of light absorbing particles, like black carbon (BC), which is the most important radiative forcer among aerosol particles given its infrared to visible spectral absorption. Most of such devices are used in European air quality monitoring networks as well as low-cost sensor on board of multicopter system. However, there is growing need for a portable and reliable source for in situ calibration of both measuring methods.

Methodology: A good candidate source is a generator based on spark discharge ionization. The spark discharge generator (SDG) produces graphitic aerosol particles and consists of a chamber filled with an inert gas (usually nitrogen or argon), which houses two graphite electrodes and connected them to a high voltage supply. In this study, a PALAS DNP 3000 (PALAS GmbH, Germany) has been used for generating graphitic particles and measured their particle number size distribution with SMPS, a total particle number concentration with an UCPC (TSI 3776) and the black carbon mass with a PAX 870 (DMT). The SDG was operated by only using the inert gas N2 and avoiding the use of dilution air, in order to facilitate the transportability and in-field operation of the generator. The N2 flow rate was fixed to 1.8 l/min. The frequency of the spark discharge spanned from 60 to 200 Hz and the voltage was set to 2500 V. Aftertreatment of the graphitic aerosol is done by rotations disk diluter (TESTO, MD 19) to adjust different levels for particle number concentration and particle mass respectively. To avoid and minimize larger graphitic particles by agglomeration a cyclone (Mesa Labs, SCC 0.695) was implemented.

Results & Conclusions: The mobility count mean diameter (CMD) of the particles produced by the SDG was varied from 48 to 71 nm, using the different setting points described above. The number concentration varied stepwise between 15.000 up to 250.000 particle/cm³ and particle mass between 2 up to 80 µg/m³ (see figure 1). Each concentration levels were measured about 11 minutes. A good linear correlation between total particle number concentration and particle mass was observed for all operation points between 48 to 71 nm (see figure 2). The SDG provides a stable source and could potentially be used for PTI counter as infield calibration unit as well as for BC monitors in air quality networks. Additionally, the system can be operated as stand-alone unit equipped with a battery pack and N2 bottle.

This work has been funded by the Modernity Fund (mFUND) of the Federal Ministry 812 of Transport and Digital Infrastructure (BMVI) under grant agreement 19F2097A (MesSBAR - Automatisierte luftgestützte Messung der Schadstoff-Belastung in der erdnahen Atmosphäre in urbanen Räumen)



Exposure to PM2.5 on the severity of respiratory infections

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For several years, epidemiological studies have shown a positive association between exposure to fine particles (PM2.5), and the severity of respiratory infections such as bronchiolitis, influenza and even more recently COVID-19 [1-2 ;4-5]. PM2.5 and respiratory infections are major public health issues. They both target the bronchial epithelium suggesting that chronic exposure to ambient particles could weaken the epithelium and make it more susceptible to viral infections which deserves to determine the underlying mechanisms. The objective of this project is to study the impact of repeated exposure to PM2.5 on the severity of viral infections, taking here the example of the influenza virus. For this purpose, an *in vitro* model of human bronchial epithelium developed from the Calu-3 cell line is used and grown at the air-liquid interface (ALI). This differentiated model allows to mimic the human bronchial epithelium in a relatively realistic way [3] and the conditions have been optimized to perform repeated exposures, since people are chronically exposed to pollutants, in particular PM2.5. PM2.5 were collected in winter on a site close to Paris being influenced by traffic and urban heating and their chemical composition characterization is in progress. Our hypothesis being that repeated exposures of the airway epithelium to PM2.5 would favour viral infection, we aim to decipher how particles can interfere with the process of viral replication and anti-viral defence. For this purpose, the cytotoxicity and viral replication will be investigated as well as the different actors of the defence such as viral receptors, pro-inflammatory cytokines, the interferon (IFN) pathway and antimicrobial peptides.

We first characterised the responses of the Calu-3 bronchial epithelium model to a single 24h exposure to PM2.5 as well as to reference diesel particles (DEP1650b) at ALI at 5, 10 or 20 µg/cm². The CYP1A1 expression was increased showing that the polyaromatic hydrocarbons present on particles became available and can therefore induce effects. Particle exposure induced the expression of the pro-inflammatory cytokines IL-6 and IL-8. They also seem to impact the antiviral signalling pathway involving IFN as they appear to increase the expression of IFN-β and the MxA genes. An increase in the expression of the antimicrobial peptide β-defensin 1, which also plays a role in the defence of the epithelium during a viral infection, was observed. We also characterised the response of the epithelium during a viral infection and during a single 24h exposure to an agonist of the antiviral defence pathways, Poly(I:C) to mimic the virus confirming the functionality of the anti-viral pathways in this model. We are currently performing single PM2.5 exposures on the bronchial epithelium followed by viral infection before moving to repeated exposures.

This work is support by the Foundation for Medical Research (ENV202003011541), the French Environment and Energy Management Agency (ADEME) and DIM Qi².

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Indoor Air Pollution and COVID-19 load in Lucknow - Capital of Most Populate Indian state

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The second wave of the SARS-CoV-2 (COVID-19) infection has hit India with full force and affected the whole country. Uttar Pradesh stands at second position with a high viral load. Air pollution has emerged as a potent factor related to the transmission of the virus helping in the facilitated spread of the virus. Although the focus lies on ambient air pollution, indoor air quality is largely neglected. A case study was done in Lucknow, the capital city for a period of three years from 2011-2014 in selected houses from 1) well-planned, 2) densely populated and 3) roadside microenvironments to quantify $PM_{10,}$ $PM_{2.5,}$ SO_2 and NO_2 in indoor and outdoor environment. Heavy metals Fe, Cu, Pb, Zn, Ni, Mn and Cr associated with $PM_{2.5}$ were also analyzed in indoor samples. The findings showed high concentrations of indoor pollutants varying from well-planned to densely populated areas. Houses situated in densely populated (Chowk area) and roadside (Alambagh) areas had very high particulate contamination. In roadside houses, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 reached upto100 µg/m^3, 66.4 µg/m^3, 0.018 ppm and 0.021 ppm respectively. The occupants of the houses exposed to a mean concentration of 299 µg/m^3 of PM_{10} and 269 µg/m^3 of $PM_{2.5}$ suffered from asthma and respiratory problems. The mean concentration of metals at all the sites were found to be, for Fe = 669.08, Zn = 31.93, Cu = 113.16, Pb = 65.9, Mn =14.4, Ni = 26.83 and Cr = 3.3 µg/m^3. A questionnaire survey was conducted in two prominent city hospitals with 1000 respiratory patients and it was found that 46% of urban people were suffering from acute respiratory infections, majority of them belonging to roadside and densely populated areas. During the second wave of COVID-19 which hit the city in March 2021, Alambagh, Aliganj, Chinhat, Indiranagar, Chowk and Aishbagh were identified as the most affected areas, reporting the highest cases. The findings of the case study may be suggestive of the fact that those already exposed to a high level of air pollution indoors are susceptible to the COVID infection. The results of the study correlated with the number of cases reported from roadside and densely populated areas.

Keywords: Indoor air, Lucknow, COVID-19, particulate matter

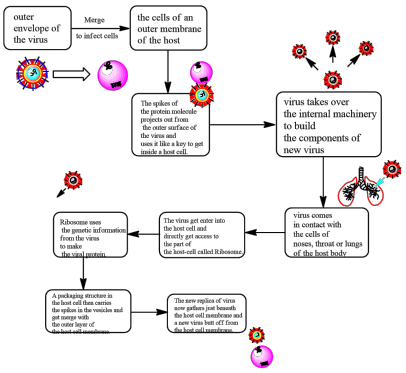

Fig. 1 Coronavirus infecting living cells of the respiratory system and causing respiratory infection

Controlling the indoor air pollutants utilising the solid industrial waste: a case study on coal fly ash

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style="text-align: center;">**Controlling the indoor air pollutants utilising the solid industrial waste: a case study on coal fly ash**

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Abstract :

Industrial waste is considered problematic due to increase in industries world wide. It can be in any form solid, liquid or gas. In spite of several waste management programs a huge amount of waste disposal takes place. Theses waste disposal poses certain environmental threat due to its hazardous and toxic constituents all over the world. The coal fly ash utilisation has received a great deal of attention over the past two decades in providing more sustainable solutions to waste management. It has been reported that there is a significant potential for the increased utilization of coal fly ash both in its raw and refined state. It is suggested that, by processing the coal fly ash, the scope of creating new industrial synergies can be enhanced. Although, certain work has already been done in the field of utilization of fly ash, yet, some other areas such as volatile organic compounds [VOCs] removal and removal of other indoor pollutants still remains an undiscovered area. Air pollution has become one of the major threat to human being in this century. Specifically, indoor air pollution is often under looked or confused with ambience air pollution. In 2021, revised guidelines for indoor as well as outdoor air pollutants such as $PM_{2.5}$, PM_{10}, NO_2, SO_2 and CO has been released. People spend almost 90% of their time indoors which has been further increased due to COVID-19, making monitoring and abatement of indoor air pollutants further more essential. This paper brings out the potential applications for coal fly ash as a raw material, as a soil amelioration agent in agriculture, in the synthesis of geopolymers, for use as catalysts and catalyst supports, as an adsorbent for gases and waste water processes, and for the extraction of metals. Along with that the article also discusses the prominent indoor air pollutants such as VOCs, PMs, NO_2, SO_2, O_3 etc., and their effect on humans as well as environment. The paper concludes with a status report on emerging technologies using industrial waste for the mitigation of the indoor air pollutants. This article is intended to help professional of all the disciplines to regulate and consider industrial waste usage as an emerging pollution control technique.

Key words: Fly ash, volatile organic compounds,Industrial solid waste, Indoor air

Assessment of Indoor air quality in three different hospitals in Lucknow city-Most populous city in India

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Abstract

Indoor air environment comprises of a combination of biological contaminants viz. bacteria, fungi, viruses, algae along with their by-products namely endotoxins, mycotoxins, volatile organic compounds, etc. Biological contaminants have been characterized based on whether they are allergenic, infectious, competent of inducing toxic or inflammatory symptoms in human beings. Their major sources include pets (dogs, cats, birds, etc.), plants (pollen, odors, allergens), and building materials. However, their consequences may be intensified through certain factors such as temperature, humidity, ventilation, carpets, tissues (mites), moisture content, etc. Presently, there is an absence of awareness regarding biological contaminants, specifically in an indoor environment. These can be a potential source for various human diseases. This study was commenced to assess the indoor air quality concentration including $PM_{2.5}$, SO_2, NO_x, and heavy metals along with microbial contaminants, their isolation, and identification in three different hospitals in Lucknow. $PM_{2.5}$ was measured by APM 550 medium volume sampler (Envirotech) at a flow rate of 17.571/m with a PTFE filter paper diameter of 47mm. A total of six sampling sites were taken for the assessment of indoor air quality of different pollutants including bacteria and fungi from three different hospitals by using the passive method also known as the gravitational settling method from February to April 2022. Microbial samples were collected from a different ward and OT using exposed Petri plates with (MacConkey agar, Sabouraud dextrose agar, nutrient agar) media for the growth of microbial contaminants. Followed by the identification of bacteria media plates which were incubated for 24-48 hours at 37˚C and for fungi at 30˚C for three weeks. The presence of bacteria was identified by the gram staining process and fungi from the lactophenol cotton blue staining process. Out of six samples, gram-negative and gram-positive bacteria were isolated. It was observed that a high bacterial and fungi load was there in the general ward of the hospitals. Therefore, the present study inspects the interconnection between biological contaminants and human health. Also, it has been aimed to provide comprehensive information about the biological contaminants present in different places in hospitals which will further help in monitoring and regulating the same.

Keywords: Indoor air quality, nosocomial infection, exposure, mold, bacteria, indoor pollution.

Sintering rate of nickel nanoparticles by molecular dynamics

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Nickel nanoparticles (Ni NPs) are widely used in batteries, catalysts, and filters. Properties of Ni NPs strongly depend on their crystal structure and morphology quantified by the state (i.e., solid, transient, or liquid phase) of primary particles (PPs), and size of hard-agglomerate (aggregate) and PPs [1]. The growth rate of PPs during gas-phase synthesis is determined by their sintering rate, which is sensitive to the state of PPs. At low temperatures and for large PPs, solid state diffusion of atoms in PPs controls the sintering. However, with increasing temperature or decreasing PP size, viscous flow sintering becomes dominant and the state of particles changes as they approach their melting point [2]. Using molecular dynamics (MD), the crystallinity and sintering of Ni NP dimers are investigated. Accuracy of the employed force field is validated by obtaining X-ray diffraction patterns of sintering nanoparticles and their melting temperature. For $d_p \geq 6$ nm at T< 1380 K, MD-derived characteristic sintering times (τ_s) based on the evolution of dimer specific surface area are in excellent agreement with literature for solid state sintering [1,3]. With decreasing PP diameter or increasing temperature, the state of PPs quantified by their disorder (or Steinhardt) parameter changes due to progressive melting starting from their surface that results in significantly lower τ_s compared to those predicted by solid state diffusion [2]. These values are in excellent agreement with predictions by viscos flow sintering for fully melted particles [4]. A general formula for the characteristic sintering time of Ni NPs has been derived valid for all particle states, and its performance in predicting the evolution of Ni agglomerate morphology quantified by its mobility and primary particle diameters during gas phase sintering in a flow reactor is demonstrated [3].

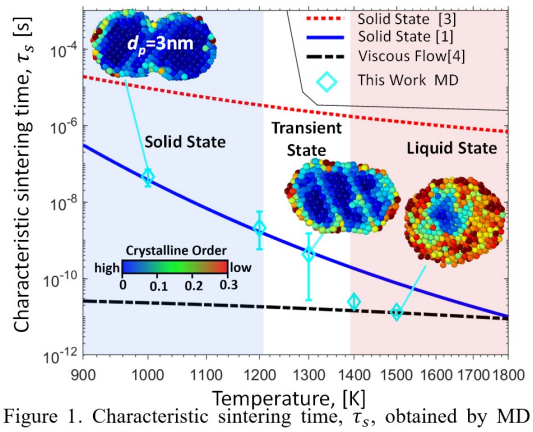

Figure 1. Characteristic sintering time, τ_s, obtained by MD simulations (diamonds) compared with the literature for solid state sintering (blue [1] and red [3] lines), as well as for viscous flow sintering (black line [4]), along with particle cross-section snapshots (insets) colored based on the local disorder parameter, D.

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Design and development of a model policy document for controlling air pollution in Delhi and NCR of India.

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Air pollution has emerged as one the biggest global health threats. In the year 2021 Delhi was ranked as the world's topmost polluted capital city and 4th most polluted city with India ranking 5th among 117 countries surveyed and 35 of the world's 50 cities having worst air quality were found to be located in India with 6 of them being in the top 10 of the rankings [1]. Air pollution was the second leading risk factor for disability-adjusted life year (DALYs) in India as a whole with outdoor air pollution causing 6.4% of India's total DALYs in the year 2020 and indoor air pollution causing 4.8% [2]. The health issues related with air pollution on heart, lungs, cancers, mortality, morbidity, etc. have been well studied world over including India [3, 4]. Urbanization, transportation, industrialization, power generation, and agricultural activities are the key drivers air pollution in India; a country with diverse geographical, demographic, cultural and political backgrounds, making it a very complex challenge to develop air pollution control policies for it. There is always an economic lobby crying for more industrialization to create newer jobs to fuel the economy which consequently has a negative impact on environment in general and air quality in particular. The present air pollution policies in India and specifically in Delhi and its surrounding National Capital Region (NCR) like Emission tax, Carbon tax or Polluter's Pay Principle have failed to find any feet and hence future policy has to be designed, deliberated and developed for optimal and efficient distribution of incomes and resources to stabilize and then reduce the air pollution levels. This research paper tries to put forward an outline to evolve such a policy specific to Delhi and NCR. The methodology adopted is critical review of existing literature on the subject and recommendation of new policy measures with respect to topography, meteorology, vehicular and industrial emissions, construction, thermal power plants, fire cracker usage, stubble burning, dust storms from neighbouring countries, open burning of waste, smoking, migrant issues, re-suspended road and ground dust and lack of co-ordination among multiple authorities. It is expected that the proposed research will provide a holistic and long-term policy solution in curbing the problem of air pollution in Delhi and NCR. It will serve as a reference document for governments and other stakeholders while formulating policies related to air pollution for bridging the gap between the politics, economics and science of air pollution.

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Nanoparticles – Neurodegeneration in nematode *C. elegans*, a causative relationship

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The rapid speed of industrialization in the current world has increased the severity of the global problem of environmental pollution. Interactions between environmental habitats, pollution and living organisms have recently attracted pleotropic investigations in both environmental science and toxicological research. Scientific evidence emerged that transportation-induced nanoparticles (e.g., fuel combustion, tire wear and brake wear) may promote the prevalence of neurodegeneration and neurodegenerative diseases. We are investigating the effects of silica nanoparticles on single neurons such as serotonergic, dopaminergic and GABAergic neurons in which nano-silica perturbs neural signaling and correlates with neuromuscular behavior defects in the nematode *Caenorhabditis elegans*. The results corroborate the idea that neurodegeneration in single ADF and HSN serotonergic neurons contributes to behavior obstructions after exposition of *C. elegans* to nanoparticles. Interestingly, in the dopaminergic neurons, axonal transport of the PDE neuron is impeded, whereas CEP and ADE neurons are preserved. Loss of GABAergic neurons is also enhanced in nano-silica treated worms. Age-groups vulnerable to silica nanoparticles will be further studied with respect to protein homeostasis with by proteomics analysis. The imbalance of protein homeostasis is interrogated as target of nanoparticle-effects and molecular weak point that plays an important role in neurotoxicity of *C. elegans* at a certain age.

Nanoparticle Metrology, Short Video (Exhibitors)

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J. Spielvogel[1]

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The world has changed a lot since TSI started building instruments in 1961, but some things remain the same. TSI's commitment to our customers' success, our dedication to research, and our drive to make the world a better place have always been part of our history.

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