Swiss Aerosol Award 2022

DNA-Barcodes for indoor aerosol exposure and

Single aerosol particle detection by acoustic impaction

This year we could present the award to two researchers for their excellent work out of many submissions:

Anne Lüscher

The circulation of pathogens in the form of aerosols is an important route of transmission of diseases and respiratory infections in particular. However, the COVID-19 pandemic has once again shown that airborne virus distribution is extremely complex and that current understanding is insufficient to make accurate predictions about the transmission dynamics in practice. To improve this understanding, tracers - substances that behave similarly to aerosolized viruses in terms of size and properties - are essential. Anne Lüscher and her co-authors therefore developed a new tracing method to improve and simplify the study of indoor aerosol dynamics. In their award-winning work, they were able to show that silica particles with encapsulated DNA (SPEDs) can be deployed in aerosolized form, followed by recapturing and quantification at different positions. This is enabled by "DNA barcodes" enclosed in the particles: Short synthetic DNA sequences can be reliably detected by the PCR method with high accuracy and a sensitivity at the single-particle level. The silica matrix on the one hand protects the DNA and, on the other hand, can be produced size-specifically. In the published work, position-, ventilation- and time-dependent effects of indoor aerosol exposure could be demonstrated using SPEDs, enabling conclusions on the room architecture and air circulation. The proposed setup requires little technical infrastructure and is therefore mobile, making it particularly suitable for the investigation of real-life exposure scenarios in indoor settings, transportation scenarios and the environment.

Original title: Luescher, AM, Koch, J, Stark, WJ, Grass, RN. Silica-encapsulated DNA tracers for measuring aerosol distribution dynamics in real-world settings. *Indoor Air*. 2022; 32:e12945. https://doi.org/10.1111/ina.12945

Nadine Karlen

At the University of Applied Sciences FHNW, Brugg-Windisch, a novel aerosol measurement method called DustEar has been developed that detects particles acoustically. It allows the direct measurement of the mass of single particles. From this, the PM concentration can be determined. In Switzerland particle PM exposure is regulated and total mass of airborne particles of health relevant sizes (e.g. PM10) is monitored. Therefore this measurement principle with its robust setting and direct measurement can make an important contribution in the field of aerosol monitoring.

Human health is affected by exposure to high or long-term aerosol concentrations. Due to their small size, aerosol particles can reach the lungs via the respiratory tract and also enter the bloodstream, where they can cause serious diseases. Therefore, limit values for aerosol mass concentrations are regulated by the WHO and need to be monitored. Due to the heterogeneity of aerosol concentrations and their complex interactions with the environment, long-term measurements of air pollution require both high spatial and temporal resolution for reliable statements about fluctuations or trends. Currently, there is no accurate way to determine mass-based exposure values or PM concentrations at specific locations in real time. To close this gap, DustEar enables reliable and cost-effective PM measurements.

In the awarded work, the proof of concept for a new measurement method was provided where aerosols are detected acoustically. The measurement principle allows the in-situ detection of liquid and solid particles. In the DustEar particles are accelerated in a nozzle and impact on a piezoelectric sensor. Each impacted particle generates a characteristic signal pulse whose amplitude is proportional to the particle mass. The study showed a current detection limit of 50 picogram particle mass that corresponds to a particle size of several micrometers. The challenges in the development of this measurement method included turbulence-free flow guidance with a defined flow profile, the design of a low-noise electronic circuit and the suitable selection of a piezo transducer. On the one hand, the transducer has to be robust against the noise of the air flow and, on the other hand, it has to be sensitive enough to detect the particle signals. The goal of a current Innosuisse project is to further lower the detection limit to submicrometer sizes. This requires special conditions, such as a particle impaction at reduced pressure, to ensure the impaction of the small particles. To be able to detect them, the signal-to-noise ratio must be improved by several orders of magnitude by increasing the particle velocity and optimizing the electronics and sensor technology.

DustEar combines the advantages of the state-of-the-art measurement methods in a simple, robust and portable measurement device based on direct mass measurement. Thus, it will enable a denser monitoring network with comparable reference devices that allow reliable long-term measurements. DustEar can also be used for source apportionment studies due to the size-resolved data.

The new measurement principle has the potential to make a valuable contribution to one of the most important research topics of our society: the improvement of air quality monitoring.

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Original title: Single Aerosol Particle Detection by Acoustic Impaction; Source: https://ieeexplore.ieee.org/document/9768831

The Swiss Aerosol Award will be/was presented November 2nd 2022 at the 17th meeting of the Swiss Aerosol Group (SAG).

Thanks to a generous donation from the Swiss Lung Foundation, every year the Swiss Aerosol Group (SAG) can award a prize of 5'000 CHF to the best scientific publication in the field of international Aerosol research, written from within Switzerland.