2023

Pathogen transmission by aerosol particles. — A positive outcome of the COVID-19 pandemic was the focus on research aimed at understanding the mechanisms of epidemic spread and, with it, the recognition and research into the role of aerosols in the transmission of infections. The transmission mechanisms of pathogens have been investigated in hospital settings and the laboratory.

At the Pulmonology Hospital of Törökbálint and the Department of Pulmonology of Semmelweis University, in addition to monitoring airborne particles, size-fractionated samples were collected using a cascade impactor for further analysis. The focus of our investigations was micron and submicron particles. Optical particle counters measured size distributions and concentrations from 250 nm to 32 µm with a high temporal resolution and 8-h impactor sampling was performed in the range of 70 nm to 10 µm in 9 size ranges on gelatin filters during the alpha and delta variant periods. The large number (152) of size-fractionated samples allowed statistical analysis of SARS-CoV-2 RNA copies over a wide range of aerosol particle sizes. Our results showed that SARS-CoV-2 RNA is most likely found in particles with aerodynamic diameters of 0.5–4 µm but also ultrafine particles. The correlation analysis of particulate matter (PM) and RNA copies highlighted the importance of indoor medical activity. It was found that the daily maximum increase in PM mass concentration correlated most strongly with the RNA number concentration of SARS-CoV-2 in the corresponding size fractions. Our results suggest that particle resuspension from surrounding surfaces is an important source of SARS-CoV-2 RNA present in the air of hospital rooms.

In our laboratory studies, we measured the size distribution and concentration of exhaled aerosol particles and their variation over time during normal speech. In addition, the filtering efficiency of three commonly used face masks (FFP2, surgical and 2-layer cotton masks) was investigated under real conditions. A series of experiments were conducted with 28 participants in a specially designed and constructed cabin providing a cleanroom environment (Fig.1.). A Lasair III 110 cleanroom aerosol spectrometer measured size distributions of the emitted particles with high time resolution (6 s) in the 0.1–5 µm size range (Fig.1.). Our results showed that, although the shape of the size distribution curves was similar in all cases, the number of particles emitted differed significantly between individuals and generally decreased to different extents during normal speech. Based on high temporal resolution measurements, we showed that the number concentration of emitted submicron particles varied significantly as a function of speech volume. The FFP2 and the surgical masks showed robust performance under real conditions, even for the smallest size ranges tested, with a filtering efficiency of approximately 80%. In contrast, textile masks performed less favourably, with an average filtration efficiency of around 50-60%. Our results show that while the filtering efficiency of FFP2 masks exceeds that of surgical masks, the difference is insignificant in everyday wear.

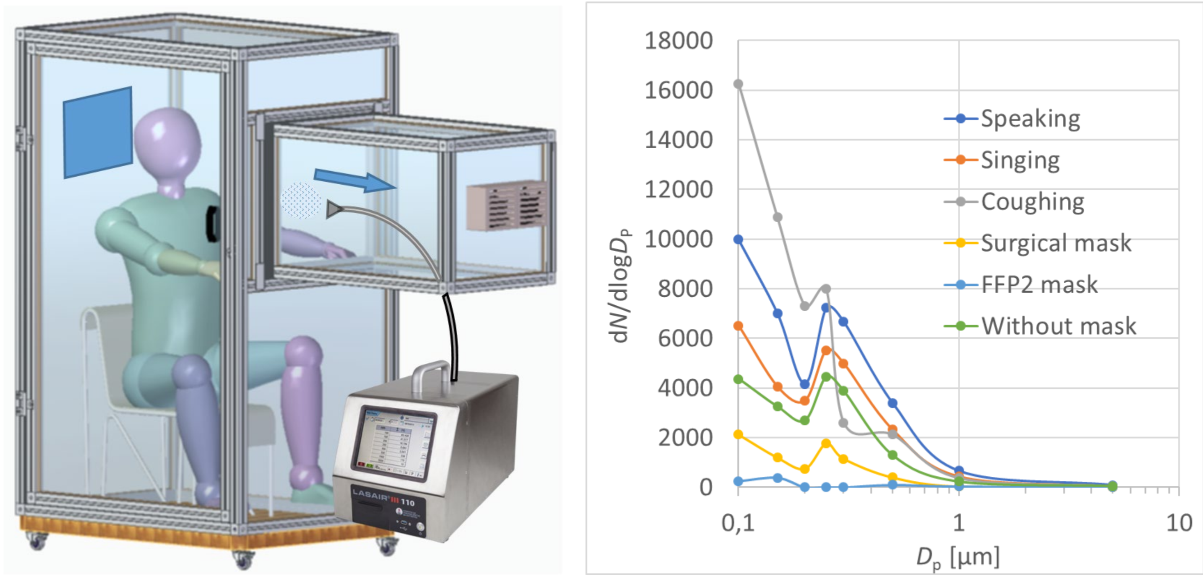

Figure 1. *The measurement set-up (left panel) and typical size distributions of emitted particles during different activities (right panel). A weak laminar flow was maintained in the cabin through a ULPA filter to achieve cleanroom conditions. For the mask tests, subjects performed the same activity (counting from 1 to 100).*

Nanoparticle emission during a 3D metal printing process — Three different particle fractions were identified in the sampled air during 3D metal printing. Significant aerosol formation was observed in the ultrafine size range, where the elemental composition of the particles changed compared to the powder used for construction (Fig.2.). The fraction in the submicron range consists of spherical particles with a slightly different composition from the starting powder and was probably formed during the laser interaction from the starting material. The particle fraction above one micron is derived from the starting powder, it was mechanically detached from the initial powder in the powder feeder.

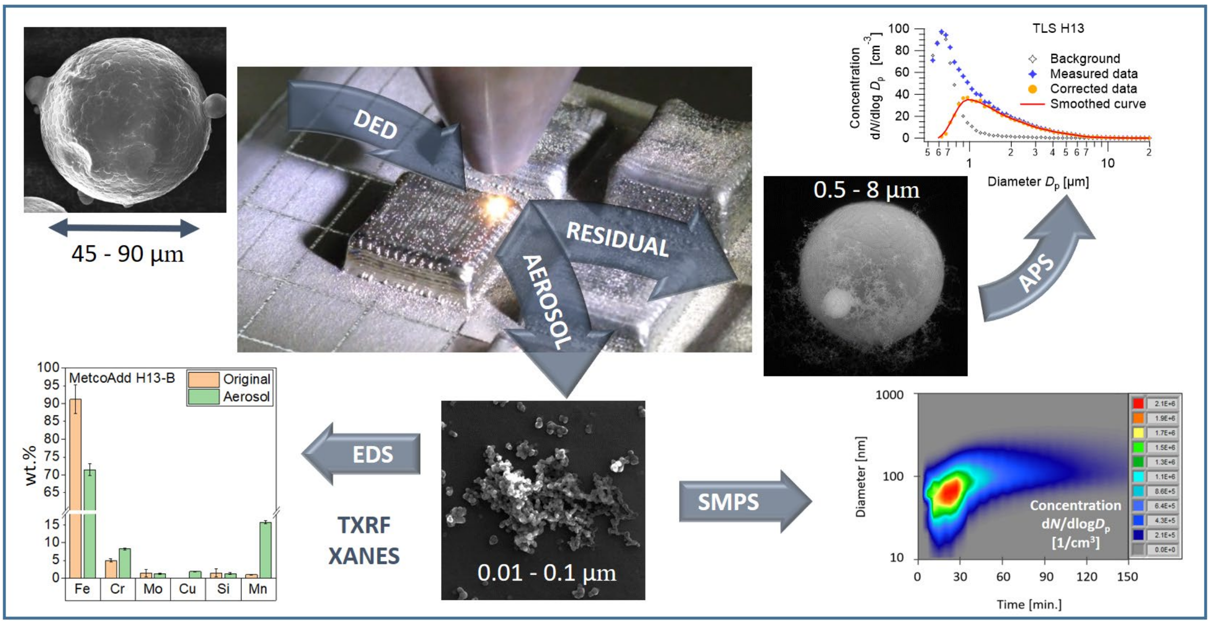

Figure 2. *Characterization of particle fractions generated during 3D metal printing.*