2024

Laser applications and optical measurement techniques

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Aerosol drug characterization. — Our group has been working for more than a decade on the experimental investigation of aerosols' physical properties and airway deposition, with a particular focus on aerosol drugs. In developing and applying the associated measurement techniques, this year's research has focused on studying particles' shape and hygroscopic properties and understanding their effects on airway deposition. In most aerosol drug deposition modelling efforts, the particles are approximated by regular spheres. However, microscope images acquired after drug formulation available in the open literature suggest that their shape is not regular in most cases. Size-fractionated sampling with a cascade impactor and image processing techniques based on electron microscopy images were used to determine the shape factor of different commercialized aerosol drugs from different vendors after the emission of a dry powder inhaler. In cooperation with the HUN-REN Energy Research Centre, we aimed to combine experimental measurements and numerical simulations to reveal the shape factors of the particles of commercialized aerosol drugs and the effect of non-sphericity on the lung deposition distribution of these drugs [1]. Aspect ratios and shape factors of drug particles in all impactor stages were determined. Computer modelling of their airway deposition was performed by neglecting and considering their irregular shape. The results of particle size measurements revealed that there was no size-specific shape factor of the particles, as they could be well characterized by a global shape factor. Although there was some inter-drug difference in shape factors, the values were quite close to unity (usually between 1.02 and 1.06), except for the fibre-shaped particles representing a minority in one case (around 1.6). The results of computer simulations of deposition distribution indicate that neglecting the irregular shape does not lead to a major distortion of the simulation results unless fibre-shaped particles are also present after the formulation.

Health effects of aerosols. — A new project has been launched on the health effects of aerosols in collaboration with Semmelweis University and the HUN-REN Energy Research Centre. The first results of a pilot study were obtained in the pulmonary rehabilitation room of the Pulmonology Clinic, where we measured the size distribution and concentration of particles formed during breathing exercises and different gym activities (on an indoor bike, elliptical trainer, ergometer, etc.), focusing on the PM2.5 fraction (Fig.2.). Eight optical particle counters [2] measured the PM concentrations at the height of the head in the physiotherapy exercise room. Healthy volunteers exercised on the gym equipment for 30 minutes, and the measurements were repeated on eight different days. The measured concentrations significantly increased when men exercised using the ergometer and the stationary bicycle compared to the background. For women, a smaller increase was registered. Bicycle exercise was associated with the most pronounced and significant increase in PM2.5 exposure during gym equipment exercise, especially when men used this device. The elevated PM2.5 concentration in closed exercise rooms is a risk factor, and using different gym equipment is associated with differences in PM2.5 increase and subsequent exposure to the individual.

While exercise is an essential health-preserving tool, inhaled air quality is important, and additional studies are needed to assess the effect of PM2.5-reducing interventions [3].

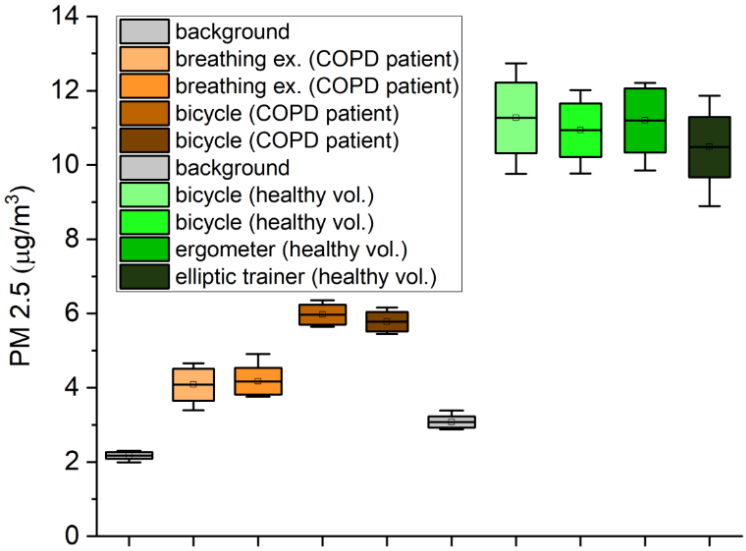

Figure 2. Measured PM2.2 concentrations in the rehabilitation room of the Pulmonology Clinic

[1] https://doi.org/10.1016/j.ijpharm.2025.125209

[2] https://doi.org/10.3390/atmos15030304

[3] https://doi.org/10.1007/s11357-024-01379-7