Method Optimization and Physico-chemical characterisation of UFPs

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Ultrafine Particles (UFP) pose a possible risk to human health because of their small particle size and their ability to penetrate deep into the lungs and to translocate to essential organs. Previous research has found a strong link between chemical composition and biological response to UFPs, which can cause oxidative stress by producing large levels of reactive oxygen species (Yuan et al., 2019). However, analysing the chemical composition can be challenging, especially for the small mass of UFPs.

Our focus is on optimizing the sampling and analysis strategies for comprehensive characterisation of the organic composition of airborne UFPs by using Direct Thermal Desorption (DTD) two-dimensional gas chromatography (GC×GC) coupled with mass spectrometry. We present a method that can separate and detect the semi volatile organic fraction at molecular levels according to their polarity and volatility providing information about the molecular structure of particle bound components. We will implement in-situ derivatisation techniques with the advantage of no need of previous extraction and easy automation.

Therefore, we are coupling a modified MOUDI impactor (cut-off 100 nm) with a sequential filter sampler (Partisol 2025, Thermo Scientific). First experiments with a sampling flow of 30 L min^{-1} for 24 hours in a rural sampling site were conducted and our method was able to determine PAH, o-PAH and the alkylated PAH in the lower picograms levels. We found noteworthy concentrations of Benzo[a]pyrene (75 pg m^{-3}) and Dibenzo[ah]anthracene (3.8 pg m^{-3}) in comparison to the target value of 1 ng/m³ which is typically determined for $PM_{2.5}$ or PM_{10} (directive 2004/107/EC). Now we propose to quantify OAs in femtogram levels, because we want to further improve the sharpness of the cut-off (break-through of larger particles could result in huge impact on found concentration) and reduce the sampling period for achieving higher time resolution.

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Reference

Yuan, Y., Wu, Y., Ge, X., Nie, D., Wang, M., Zhou, H., & Chen, M. (2019). In vitro toxicity evaluation of heavy metals in urban air particulate matter on human lung epithelial cells. Science of the Total Environment, 678, 301-308.