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Uptake of metal-sulfate particles in a human lung cell line

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Ambient airborne particulate matter (PM) is known to cause adverse health effects in humans. These effects differ with PM composition. However, it is still mainly unclear which particular particles or substances are responsible for the observed effects. In a previous study, TEM investigations of PM2.5 (particles with diameter <2.5μm) emitted from coal and tire combustion in a thermal power station revealed crystalline metal sulfates, including: anglesite (PbSO4), gunningite ($ZnSO4{\bullet}H_2O$) and anhydrite (CaSO4) particles. As these particles are emitted into the atmosphere via the flue gas of such power stations, they may be globally abundant and have an impact on human health and the environment. Therefore, in this study we examined ultrafine to coarse metal sulfates (anglesite, zinc sulfate and anhydrite) in regard to their toxic potential and uptake in human lung cells in cell culture. In order to evaluate which factors might be responsible for the observed effects, the particles were characterized both physically and chemically. Particle size and morphology were determined by scanning electron microscopy (SEM). Single particle chemistry was semi-quantified by SEM-EDX (energy dispersive X-ray spectroscopy), and particle size distribution was obtained by laser diffraction. The phases present and impurities were verified by X-ray diffraction (XRD), and atomic absorption spectroscopy (AAS) was applied to determine the powder chemical composition and estimate the solubility of the powders in culture medium. Transmission electron microscopy (TEM) combined with EDX was used to compare unexposed with exposed cells and localize particles in the cells. All particles showed toxic effects in the bioassays performed, and morphological cell changes as well as particle uptake could be documented by TEM.