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The QCM - Online Dose Measurement with high relative Humidity

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Background: Epidemiological studies show an association between the concentration of fine and ultrafine particles (PM10, PM2.5, PM1.0) in the atmosphere and the rate of mortality or morbidity due to respiratory and cardiovascular diseases. The assessment of the risk of airborne nanoparticles in workplaces or other atmospheres containing ultra fine particles is therefore an urgent task. The causes of the toxicological effects of ultra fine and nanoparticles to the human organism are yet insufficiently known. Besides the chemical composition, the physical properties of the particles seem to be of particular importance for the effects. For the quantitative assessment of the toxicity of airborne nanoparticles the dose–response relationship is tested in *in vitro* test systems using bioassays of cell cultures as sensor.

Material and Methods: For the air-liquid interface exposure of cell cultures towards aerosols the Karlsruhe exposure system was developed (Paur et al., 2008). This system consists of an isokinetic sampling unit to collect the aerosol from the particle loaded atmosphere. Particles bigger than 1 µm are removed by passing a size selective inlet. The aerosol is humidified up to 85 % and temperature controlled to 37 °C. From this aerosol sample flows of 100 ml/min each are directed into VITROCELL® exposure modules, which contain Transwell® inserts with human lung cells on the microporous membrane. The aerosol flows perpendicular onto the surface of the cell culture and the particles deposit on it. After exposure experiments of 1 up to 8 hours the cell cultures were tested for different biological responses like the viability (LDH, AlamarBlue) as well as the release of Interleukin-8 (IL-8) as a marker for pro-inflammatory changes (Diabaté et al, 2008).

For accurate determination a of the particle dose on the cell culture surface a novel online measurement technique was developed (Mülhopt et al, 2008). The sensor of a quartz crystal microbalance is placed in an exposure chamber parallel to the Transwell membrane inserts and exposed to the aerosol in the same geometry as the cell cultures. The deposited mass per area unit is monitored as a function of exposure time showing a linear relationship for a constant aerosol flow with defined particle concentration.

Depending on the kind of aerosol and the investigated conditions of exposure the relative humidity of may increase above 50 %. In these cases adsorption of water at the sensor crystal surface takes place. This results in an increased level of zero frequency for the quartz crystal microbalance depending on the amount of water on the surface which correlates with the relative humidity (Fig. 1).

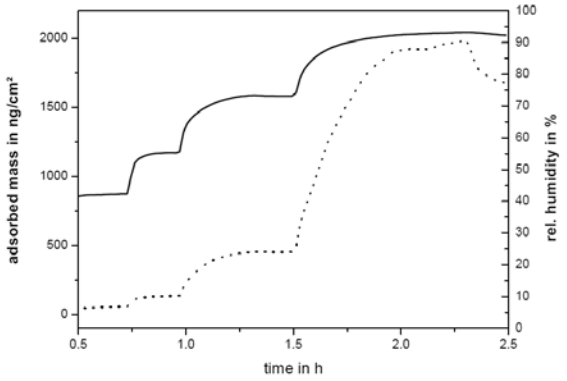

Figure 1. Correlation of mass loading on the quartz crystal microbalance for different relative humidities. Dotted line = mass loading (left ordinate). Continuous line = relative humidity (right ordinate)

Results: High relative humidity indicates a loading of the quartz crystal microbalance depending on the relative humidity. For 90 % r.h. it causes a 20 nm layer of water. This has to be considered using the QCM online dose measurement.

Conclusion: The QCM method first time provides an online dose measurement for in vitro exposure experiments at the air liquid interface also under high humidity conditions.

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