An online measurement approach to monitor diesel exhaust particles in lung cells during exposure

Ruiwen He [a], Olivier Schaub [c], Christoph Geers [c], Gowsinth Gunasingam [a], Maik Schultheiß [d], Bastian Gutmann [d], Tobias Krebs [d], Alke Petri-Fink [a,b], Barbara Rothen-Rutishauser [a]
[a] Adolphe Merkle Institute, University of Fribourg, Fribourg, Switzerland.
[b] Chemistry Department, University of Fribourg, Fribourg, Switzerland
[c] NanoLockin GmbH, Fribourg, Switzerland
[d] Vitrocell Systems GmbH, Waldkirch, Germany

Diesel exhaust particles (DEPs) can deposit onto the respiratory epithelial surface upon inhalation. The cellular burden of DEPs is important for dose-response relationships in the cells. However, non-destructive methods to continuously monitor DEPs on cells during exposure are still challenging and not well established. Our study investigated an alternative particle detection system, i.e., the miniaturized lock-in thermography Calorsito mini (NanoLockin GmbH, Switzerland), which uses a thermosensitive detection method that applies light illumination to induce heat of carbon-based particles. This Calorsito system was further integrated into the commercially available Cloud Alpha system (VITROCELL Systems GmbH, Germany) to combine cell exposure to particles under the air-liquid interface (ALI) conditions and online monitoring of particles on cells. To test system performance, the Cloud Alpha / Calorsito device was used to expose lung cells (i.e., A549 epithelial type II lung cells) to a standard DEP sample (SRM2975) at different concentrations. Particles deposited on cells were then measured with the Calorsito system under a light wavelength of 525 nm. A positive linear relationship (R2 = 0.98) was established between the thermal emission signals and DEP levels ranging from 0 to 500 ng/cm2, with a limit of detection (LOD) at around 40 ng/cm2. The interaction of DEP with cells was verified by transmission electron microscopy (TEM). Our results indicate that the Cloud Alpha/Calorsito device can combine cell exposure to DEPs and DEP monitoring on cells at a relatively low concentration. Further studies on continuous monitoring of DEPs are still ongoing to evaluate the interaction of DEPs with lung cells during exposure.