

Highlights of Analytical Sciences in Switzerland

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A Fast and Reliable *in vitro* Method for Screening of Exhaust Emission Toxicity in Lung Cells

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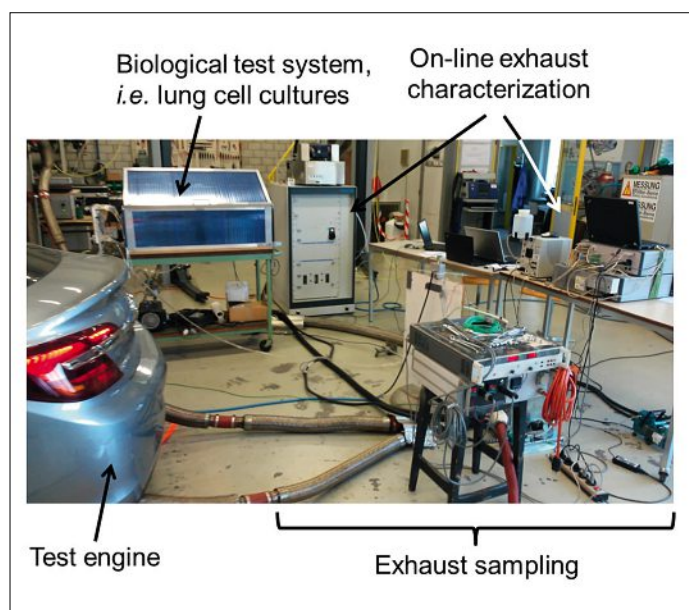
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Pollution by vehicles is a major problem for the environment due to the various components in the exhaust gases, *i.e.* gaseous and non-gaseous compounds such as particulate matter. Epidemiological studies demonstrate the profound impact of vehicle emissions upon human health.^[1] Such studies, however, cannot attribute an adverse effect to a certain exhaust component, which renders decision-making difficult when defining which emission sources should be regulated more stringently.

Reduction in emission of certain exhaust constituents and increased engine efficiency can be measured by technical means (see the Analytical Highlight of Heeb *et al.* in the next issue of CHIMIA). Standardized protocols for exhaust toxicity assessment are lacking and rely in many aspects on epidemiological and *in vivo* studies. Reasonable alternatives are *in vitro* studies using



Overview of the exposure system with the engine on the chassis dynamometer, the measuring units and the exposure box.

highly standardized cell cultures such as a 3D model of the human airway epithelium composed of epithelial cells and two types of immune cells, *i.e.* macrophages and dendritic cells. They can be used in combination with an exhaust system for exposure of lung cells to complete engine exhaust. The emission samples of an engine of choice can be taken directly at the exhaust and brought onto the lung cell surface with exhaust characterisation being performed on-line.

The system was established for scooter exhaust and has also been adapted for diesel cars.^[2] It yields reproducible results, provides the needed sensitivity for detecting differences in biological responses, and allows for differentiation between effects induced either by gaseous or by particulate components of the complete exhaust.^[3]

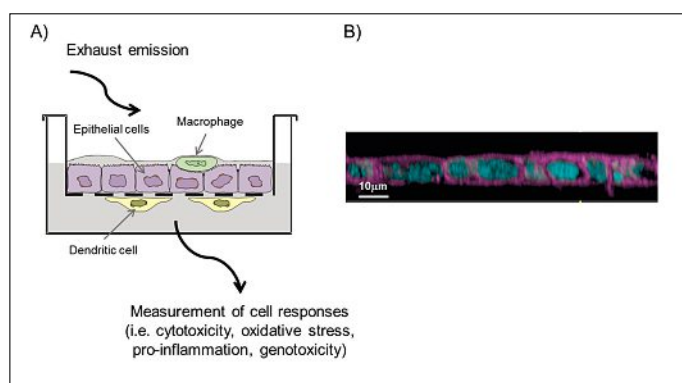
This advanced exposure system is well suited for risk assessment of exhaust emissions as well as for investigations on how engine type, exhaust after-treatment technologies, fuel additives, and fuel types affect acute exhaust toxicity.

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- [1] A. J. Ghio, M. S. Carraway, M. C. Madden, *J. Toxicol. Environ. Health B* **2012**, *15*, 1.
- [2] L. Müller, P. Comte, J. Czerwinski, M. Kasper, A. C. R. Mayer, A. Schmid, L. Rosinus, M. J. D. Clift, S. Steiner, P. Gehr, B. Rothen-Rutishauser, *Toxicol. Env. Chem.* **2012**, *94*, 164.
- [3] S. Steiner, J. Czerwinski, P. Comte, O. Popovicheva, E. Kireeva, L. Müller, N. Heeb, A. Mayer, A. Fink, B. Rothen-Rutishauser, *Atmos. Env.* **2013**, *81*, 380.



Exposure of lung cell cultures with the exhaust emissions. A) Schematic drawing of the 3D cellular model of the human airway epithelium composed of epithelial cells, macrophages and dendritic cells. The cells as well as the cell culture medium can be sampled to assess various cell responses. B) Laser scanning micrograph (xz-projection) of the epithelial cells grown on a porous filter insert. F-actin is shown in violet, the cell nuclei in light blue.

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