Hazard assessment of aerosolized graphene-related nanomaterial in human epithelial lung tissue *in vitro.*

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Abstract
Graphene-related materials (GRM) have promising properties for a wide range of new high-technology applications such as in electronics, photonics, and energy storage, resulting in mass production. However, concerns have been raised regarding their possible interaction with humans during the life-cycle, especially with the respiratory system, as being the primary route of exposure for airborne particles [1]. It has been shown that GRM can be respirable and thus can deposit beyond the ciliated airways following inhalation, resulting in pulmonary inflammation [2]. In the current study a 3D *in vitro* model of the human epithelial lung tissue barrier composed of epithelial cells, macrophages and dendritic cells [3] has been used for evaluating cell membrane permeability, (pro)inflammatory response (tumour necrosis factor alpha and interleukin-8 detection), as well as cell viability and oxidative stress induction after exposure to aerosolized GRM at different concentrations, corresponding to relevant GRM doses after inhalation exposure [4] (ranging from 0.2 to 1.5 µg/cm^2). Material aerosolization was performed using the commercially available nebulizer VitroCell®Cloud system, coupled to the Quartz Crystal Microbalance for assessment of the aerosolized material deposition; the latter was additionally visualized using transmission electron microscopy (TEM, FEI Tecnai spirit) (Fig. 1). First results have shown that nebulization of graphene oxide (GO) resulted in a dose-dependent material deposition. None of the investigated parameters was elevated for all the concentrations tested. Further investigations are ongoing to assess effects after a prolonged exposure to GO and different types of GRM such as graphene nanoplatelets, which are forecast to represent a majority of the market value of the graphene market in the year 2026 [5].

References
[1] Oberdorster G, Stone V, Donaldson K, Nanotoxicology, **1** (2007) 2-25.
[2] Schinwald A, Murphy FA, Jones A, Macnee W, Donaldson K, Acs Nano **6** (2012) 736-746.
[3] Rothen-Rutishauser BM, Kiama SG, Gehr P, Am J Resp Cell Mol **32** (2005) 281-289.
[4] Su WC, Journal of Occupational and Environmental Hygiene **13** (2016) 48-59.
[5] Ghaffarzadeh K. Report: Graphene, 2D Materials and Carbon Nanotubes: Markets, Technologies and Opportunities 2016-2026. Published by: IDTechEx, March, 2016. (http://www.idtechex.com/research/reports/graphene-2d-materials-and-carbon-nanotubes-markets-technologies-and-opportunities-2016-2026-000465.asp)

Figures

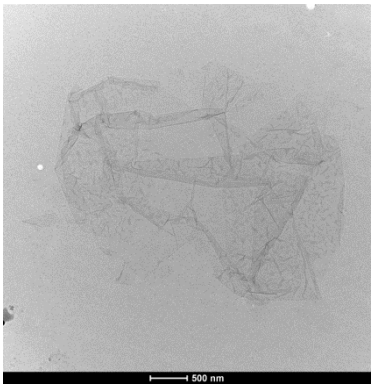

Fig. 1: Transmission electron micrograph of aerosolized (nebulized) graphene oxide.