

System for Airborne Nanofibers Exposure Monitoring

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Today's advances in man-made nanomaterials bring new and unprecedented risks to employees along the whole value chain. Airborne, inhalable nanofibers pose asbestos-like health risks when inhaled. CSEM developed with Stat Peel AG and the University of Geneva a compact dosimeter for the selective detection of airborne nanofibers, e.g. carbon nanotubes (CNTs), in workplaces.

Asbestos fibers have undisputable technical qualities. However, history taught us a painful lesson: prolonged inhalation caused fatal illness (lung cancer, mesothelioma), leading to more than 2 million deaths worldwide. Today, asbestos fibers are banned, but new, highly promising materials, such as carbon nanofibers (CNTs), emerged and are praised for their exceptional properties: Are we about to make the same mistake again?

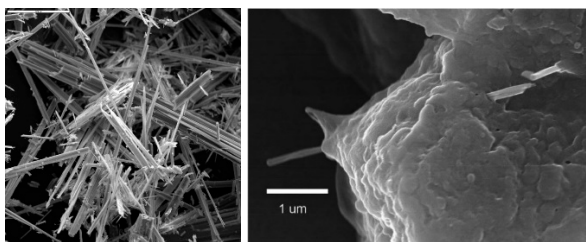


Figure 1: Left: Asbestos fibers^[1] (left); MWCNT penetrating alveolar epithelial cells of the lung^[2] (right).

As the use of nanomaterials grows, so do the dangers. Nanofibers can pose health risks^[3] and existing devices cannot detect CNTs reliably and discern them from less harmful particles like pollen, dust or carbon black from diesel exhaust. Both, SUVA and NIOSH (US institute for occupational safety and health) proclaim that all types of CNTs should be considered an occupational respiratory hazard.



Figure 2: Airborne nanofibers detection system.

Stat Peel has developed together with CSEM and University of Geneva a system, based on a wearable unit and a desktop reader that will protect both employees' health and employers' liability. The high-tech but easy to use detection system can monitor an individual's long-term exposure to nanotubes in

workplaces. It allows university labs, R&D departments, start-ups, fiber producers and any company using material containing CNTs to monitor every individual employee – a must-do in any occupational environment.

Health effects resulting from deposition of an aerosol in the respiratory tract depend on the dose received and the body's response to the particles. Continuous monitoring is therefore needed with a wearable dosimeter, worn by employees in risk of exposure, close to the personal breathing zone, reflecting the inhaled dose, which can differentiate between inhalable, thoracic and respirable fractions.

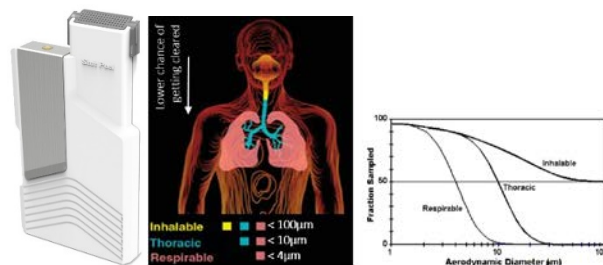


Figure 3: Wearable sampling unit for airborne nanofibers, enabling a differentiation between different size fractions.

The features of the developed system include:

- unprecedented selectivity, distinguishing CNTs from dust and carbon black, even different CNT types
- 10⁴ times lower limit of detection (absolute 0.2 ng) than the recommended exposure limit by NIOSH
- more than 10³ times lower limit of detection than state of the art thermal optical analysis for elemental carbon^[4]

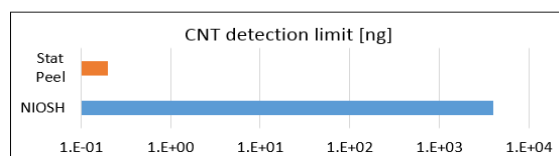


Figure 4: Stat Peel 10'000 lower limit of detection compared with NIOSH recommended exposure limit.

The monitoring technology is based CSEM's expertise in nanotechnology, microfabrication, microfluidics, low-power electronics for wearables and system integration. The system can be adapted to detect different types of airborne nanofibers.

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- Stat Peel AG, Glarus, Switzerland, statpeel.com

[1] <http://usgsprobe.cr.usgs.gov/picts2.html>

[2] R. Mercer et al. Distribution and persistence of pleural penetrations by MWCNT. Particle Fibre Toxicology 7:28.

[3] K. Yamashita et al. CNTs elicit DNA damage and inflammatory response relative to size and shape. Inflammation 33: 276-280.

[4] NIOSH. Occupational Exposure to Carbon Nanotubes and Nanofibers. Current Intelligence Bulletin 65.