Characterization and emission measurements of multi-walled carbon nanotube release during production

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The fields in which carbon nanotubes (CNTs) are found useful are rapidly growing, causing an increased demand worldwide. The industry is looking for ways to improve their production and thus increase the amount of CNTs being handled. This, together with the fear that exposure to CNT particles may cause similar health effects as asbestos (Donaldsson, 2006), create a need for accurate methods of emission assessments. We present results from field measurements performed using a range of techniques to assess emissions and exposure at a small-scale CNT producer that utilize the arc-discharge method for production of multi-walled CNTs.

Emissions and exposures when performing different work tasks in the production were examined including full-shift personal measurements. Samples of airborne particles were collected both in the emission zone and in the breathing zone of the workers. By using cyclones (BGI4L, BGI) respirable (cut-off 4µm aerodynamic diameter) dust fractions, were collected on polycarbonate (37 mm, 0.4 µm pores) filters. Particles were studied with Scanning Electron Microscopy (SEM) and online instruments were used both in the emission zone (<10cm from the source) and in the background (3 m from the closest known source). CNT containing particles were classified into 4 types displayed in figure 1. The size distribution of all measured particles in one sample is shown in figure 2.

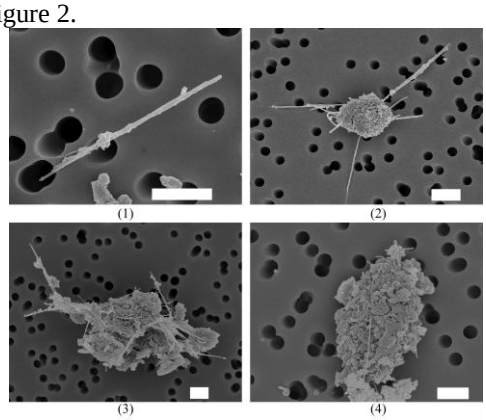

Figure 1 CNT particle types (1-4). The white scale bar equals 1 µm in each image.

Emissions of CNTs were detected in 9 out of 16 samples, with a CNT content of up to 11 CNT particles per cm^3. The CNT containing particles found in the respirable fraction did seldom exceed a length of 5 µm. Most of the CNT particles had dimensions larger than 1 µm, i. e. much larger than the mean particle diameter (0.2 µm)

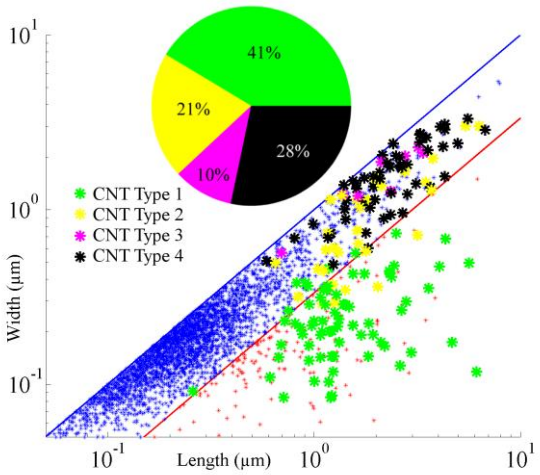

Figure 2 Distribution of measured particles in one sample, blue and red dots marks non-CNT containing particles. Particles between the blue and red line have an aspect ratio <3:1 and particles below the red line have an aspect ratio >3:1. The pie chart shows the distribution of the four different CNT types.

The combination of online instrumentation and SEM analysis contributed to clearly showed when emissions occur and what kind of particles that were emitted. The results show that several tasks in the production could cause workplace exposure.

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