Emission measurements of multi-walled carbon nanotube release during production

Ludvigsson, Linus; Isaxon, Christina; Nilsson, Patrik; Hedmer, Maria; Tinnerberg, Håkan; Messing, Maria; Rissler, Jenny; Skaug, Vidar; Bohgard, Mats; Pagels, Joakim

Published in:
Proceedings of the Annual Symposium of the Nordic Society for Aerosol Research (NOSA)

2012

Link to publication

Citation for published version (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Emission measurements of multi-walled carbon nanotube release during production

L. Ludvigsson1, 2, C. Isaxon2, P. T. Nilsson2, M. Hedmer3, H. Tinnerberg3, M. E. Messing1, J Rissler2, V. Skaug4, M. Bohgår2, J. Pugels2

1Solid State Physics, University of Lund, SE-22100, Lund, Sweden
2Ergonomics and Aerosol Technology, University of Lund, SE-22100, Lund, Sweden
3Occupational and Environmental Medicine, University of Lund, SE-22100, Lund, Sweden
4National Institute of Occupational Health, PB 8149 Dep, 0033 Oslo, Norway

Keywords: Carbon nanotubes, emission measurement, SEM

Introduction
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 measurement of both personal and in the respiratory zone of the workers.

Methods
Different tasks in the production were measured as well as full-shift personal measurement. Air samples were collected both in the emission zone and in the respiratory zone of the workers. By using cyclones (BGI4L, BGI) respirable (<5 µm aerodynamic diameter) dust fractions, were collected on polycarbonate (37 mm, 0.4 µm pores) filters. Filters were analysed using scanning electron microscopy (SEM) and online instruments were used both in the emission zone (<10 cm from the source) and in the background (3 m from the closest source).

Table 1. SEM results from filter measurements.

<table>
<thead>
<tr>
<th>Task</th>
<th>Total ± σ (0.01-5 µm) (cm²)</th>
<th>CNT containing particles ± σ (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieving, mechanical work-up</td>
<td>324±4</td>
<td>11±1</td>
</tr>
<tr>
<td>and packaging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaving of deposits</td>
<td>410±10</td>
<td>3.4±0.9</td>
</tr>
<tr>
<td>Opening of the reactor</td>
<td>1095±43</td>
<td>N.D.</td>
</tr>
<tr>
<td>Functionalization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part I</td>
<td>162±4</td>
<td>1±0.4</td>
</tr>
<tr>
<td>Personal Exposure</td>
<td>120±2</td>
<td>2.0±0.2</td>
</tr>
</tbody>
</table>

Conclusions
Emissions of CNTs were detected in 9 out of 16 samples (selected results in Table 1). CNT structures were found in all personal exposure measurements. The CNT structures found in the respirable fraction did seldom exceed a length of 5 µm and CNT structures classified as fibres (aspect ratio >3:1 (Figure 1)) were in most cases shorter than 3 µm. The fraction of CNT structures compared to other particles was small. Emissions during activities occurred as peaks (Figure 1).

The CNT concentration was estimated to 11 CNT containing particles/cm³ during the task performed in Figure 1 (Cleaving of deposits). CNT concentration in the personal exposure measurement was measured to 2 CNT containing particles/cm³. The combination of online instrumentation and SEM analysis gave a deep understanding of when emissions occur and a detailed description of what kind of particles that were emitted. The results show that several tasks in the production could cause workplace exposure occur.

This work was performed within the FAS centre METALUND and supported by the Swedish Council for Working Life and Social Research (FAS) and nmC@Lund