Release characteristics of nanomaterials during drilling and sawing of nano-composites

Yaobo Ding[1], Klaus Vilsmeier[2], Wendel Wohlleben[2], Michael Riediker[1,3*]

[1]*Institute for Work and Health (IST), University of Lausanne and Geneva, Lausanne, Switzerland*
[2]*Material Physics Division, BASF SE, Ludwigshafen, Germany*
[3]*SAFENANO, IOM Singapore, Singapore*
**Corresponding author: Michael.Riediker@hospvd.ch*

Keywords: occupational exposure, nanoparticles, release, nanocomposites

Nanomaterial composites feature superior physical and chemical properties compared to traditional materials. However, for risk assessment purposes, it is important to know if humans can get exposed to these nanomaterials when processing the composites. An important potential inhalation exposure scenario is that the nanoparticle fillers might escape from the polymer matrix as free particles during mechanical treatments. This study aimed to determine the characteristics of particles released during controlled mechanical treatments of nanocomposites.

We tested the release from manual sawing and self-controlled drilling processes. Nanofiller samples were treated in an enclosure, which isolated the processes. Factors such as driller diameter, drilling speed and drilling pressure were varied to test their influence on the release. The released particles were characterized for particle number concentration, size distribution and morphology.

Pure PolyUrethan (PU), PU/SiO_2, PU/Carbon black and PU/CarbonNanoTube (CNT) composites were mechanically treated. In the drilling process, the net particle releases were not significantly changed by nanofillers. A reduction of particle generation (number and mass) was observed for PU/CNT samples. Larger driller diameter and faster drilling speed produced higher particle concentrations. For all drill-tested materials, the airborne particles appeared as irregular flake-like shapes ranging from 1-20 μm in diameter. In the sawing process, overall much less particles were released. SiO_2 and CNT filler composites did not produce higher particle concentrations compared to reference samples, while PU/carbon black showed large increases in particle generation. In the latter case, a peak of the number concentration most often appeared in the size range around 100 nm.

The preliminary tests showed that the treatment methods, processing parameters as well as the nanofiller types all influenced the release process. Morphological studies will continue to verify the identity of released particles. It also remains to be further explored whether different processing methods go along with different release mechanism for the same type of nanocomposites.