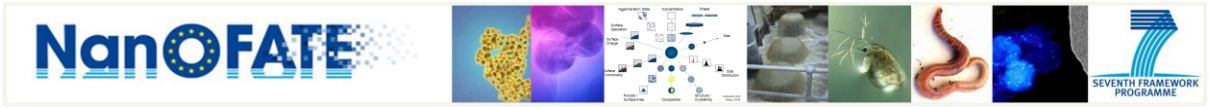

Advice note 7 – NanoFATE has demonstrated that for zinc oxide (ZnO) particles, properties like coating and size do importantly differentiate the ENPs in terms of their fate and toxicity.

Advice notes to answer the big five questions

NanoFATE has identified five "Big Questions" important to our understanding of the ecotoxicology of engineered nanoparticles and will help provide key information required to assess the risk that these materials may pose to the environment.

This advice note is in response to the question:
Given that particles can differ in their properties (including their core constituents, size, coating, and crystalinity) when can nanoparticles be treated as a single entity if a 'case by case' approach is needed and chosen?

NanoFATE has studied the effect of coatings on the behaviour of zinc oxide (ZnO) nanoparticles in soils.

Rationale & Methods

NanoFATE partners determined the effect of long-term equilibration on the dissolution behaviour and toxicity uncoated and coated ZnO ENPs (BASF, Z-COTE HP1 and Z-COTE), non-nano ZnO and ZnCl2 to the soil-dwelling springtail *Folsomia candida* in Lufa 2.2 soil. After three, six and 12 months dissolved Zn concentrations in the soil pore water were measured and the toxicity to the springtail *Folsomia candid*a was determined.

Results & Conclusions

Table 1 indicates that uncoated ZnO ENPs and non-nano ZnO were equally toxic to the springtail *Folsomia candida*, but not as toxic as ZnCl2. Upon equilibration, toxicity of both ZnO forms and the free Zn added as ZnCl2 decreased. The coated ZnO ENPs were more toxic than the uncoated ones, and toxicity did not change during the first six months of incubation. The toxicity of coated ZnO ENPs was only significantly reduced after one year, shown by an increase of the EC50 value from six months (576 mg Zn/kg) to 12 months (1817 mg Zn/kg).

This study shows that a coating may prevent the release of the (toxic) Zn ions and that toxicity may not only be explained by the free Zn. The release of Zn in soils spiked with coated and uncoated ZnO ENP continued for one year and the interaction of dissolved Zn with protons (pH) and DOC in the soil pore water contributed to a reduced bioavailability and springtail toxicity with time.

Table 1. EC50 values for the effect on the reproduction of *Folsomia candida* after 28-d exposure to Lufa 2.2 soil freshly spiked (T=0) with coated and uncoated ZnO ENP, non-nano ZnO and ZnCl2 and after three (T=3), six (T=6) and twelve months (T=12) equilibration. EC50 values are presented as total concentrations in the soil (mg Zn/kg d.w.). Corresponding 95% confidence intervals are presented in between brackets.

More information

These results along with other further examples of our work in this area can be found in our public summary "D4.3 Research report and associated research paper addressing the current state-of-the-art in analysis of ENP property effects on toxicity property–effect relationships.", and in the paper in Environmental Pollution, vol. 178; pp. 59-64.

This project is supported by the European Commission under the Seventh Framework Programme. Theme 4: NMP – Nanosciences, Nanotechnologies, Material and new Production Technologies and Theme 6 – Environment (including Climate Change). Gant Agreement no. CP-FP 247739 NanoFATE

Table 1. EC_{50} values for the effect on the reproduction of Folsomia candida after 28-d exposure to Lufa 2.2 soil freshly spiked (T=0) with coated and uncoated ZnO-NP, non-nano ZnO and ZnCl2 and after three (T=3), six (T=6) and twelve months (T=12) equilibration. EC_{50} values are presented as total concentrations in the soil (mg Zn/kg d.w.). Corresponding 95% confidence intervals are presented in between brackets.

Time (months)	coated ZnO ENP	uncoated ZnO ENP	non-nano ZnO	$ZnCl_2$
T=0	873[a] (659-1087)	1964 (1635-2293)	1591 (-)	299[a] (181-415)
T=3	749[a] (463-1035)	2847 (-)	3628<EC_{50}<8359	912[b] (-)
T=6	576[a] (263-888)	-	-	-
T=12	1817[b] (1344-2291)	>5855*	>8359*	707[b] (419-996)

* no 50% reduction in survival or reproduction was observed at the highest test concentration

- Data did not allow estimating an EC_{50} value and/or 95% confidence intervals (see text)

[a,b] indicate significant differences between LC/EC_{50} values at different time points according to a generalized likelihood-ratio test ($\chi^2_{(1)} > 3.84$; $p < 0.05$).

This project is supported by the European Commission under the Seventh Framework Programme. Theme 4: NMP – Nanosciences, Nanotechnologies, Material and new Production Technologies and Theme 6 – Environment (including Climate Change). Gant Agreement no. CP-FP 247739 NanoFATE