Innovative Materials: Safety along the Life Cycle

Environmental grouping and read-across for nanomaterials and innovative materials – are PC-properties sufficient regarding green algae?

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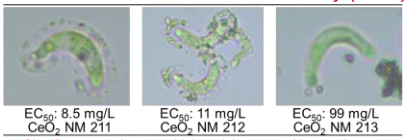
Introduction

- Nanomaterials (NM) show variation in size, shape, crystalline structure, surface modifications.
  → Grouping and read-across can help that only a limited number of NM has to be tested.
- Grouping: NMs with similar properties form a group.
- Read-across: Within a group, a data gap might be filled in by read-across; must be justified scientifically *(ECHA. 2017. Guidance on information requirements and chemical safety assessment - Appendix R.6.1 for nanomaterials applicable to the Guidance on QSARs and Grouping of Chemicals).*
- Challenge: Which properties are suitable indicators for effects and ecotoxicity?
  Suggestion of a selection of relevant parameters for green algae → SEG4nano (= Sophisticated Ecotoxicological Grouping approach fo(u)r nanomaterials) *(Kuehnel et al. 2019: NanoIMPACT 15:100173)*
  Are these parameters also suitable as indicator for innovative materials with larger diameters?

Results for green algae

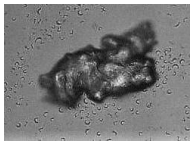
- For NMs whose toxicity is not based on the release of toxic ions (e.g. CeO_2, TiO_2), an criterion indicating toxicity to algae is extent of attachment (*Hund-Rinke et al. 2020: Nanomaterials 10(6):1021)*

CeO_2 NM attached to Rhaphidocelis subcapitata: extent of attachment is related to ecotoxicity (EC50)



CeO_2

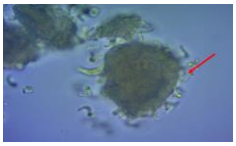
- Innovative material: micronized polyurethanes (D50 ≥ 200 µm):
  6 very different materials (ether, ester, aromatic, aliphatic: different polymer backbones / different aromaticities, different crosslinking degrees) → 6 groups based on chemical identity.
  but: no attachment, no toxicity on algae → one group based on toxicity and attachment. Size of PU exceeds size of algae significantly (≠ NM). Size as only reason for "no toxicity" is less reliable (see Y_2O_3 below).



PU

TPU ether arom and free algae

- Y_2O_3:. Algae attach to large agglomerates (primary particle size ∅ 32 nm; agglomerate size >> 100 µm) - growth is reduced - EC50 2.6 mg/L.



Y_2O_3

Agglomerate of Y_2O_3 with attached algae

Justification of the criterion "attachment"

- Agglomeration of algae and particles can e.g. damage the cell or reduce the wavelengths required for growth of algae. "Guidance Document on Aquatic and Sediment Toxicological Testing of Nanomaterials": reduction of light by attachment = toxic effect (≠ reduction of light by turbidity).
- Surface properties of materials (e.g. reactivity) can be pronounced by a close contact of algae and particles (= by attachment).
- PC-parameters descriptive for attachment could not be identified and "attachment" has to be considered as new parameter for read-across regarding algae.

Conclusion

⇨ Grouping based on PC-parameters as listed in ECHA (2017) can result in an overestimation of differences. The additional criterion "attachment" can support the PC-parameters and can reduce testing for NMs and larger innovative materials which are not toxic due to the release of toxic ions.

⇨ Number of groups
PC-parameters > SEG4nano: not critical, but options for read-across reduced, more testing.
PC-parameters < SEG4nano: more critical, groups do not reflect the different hazard.

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