Overview of (abiotic) transformation reactions in the aquatic environment which are relevant for nanomaterial risk assessment / D2.20

Introduction

Predicting the fate of nanomaterials (NMs) in natural environments is crucial to assess the risks associated with it. In aquatic environments, dissolution mechanisms are important processes, being the main drivers for the release of dissolved species often referred to as the cause of the toxicity. However, solid-phase transformation mechanisms play also an important role, controlling the fate of NMs and mitigating their toxicity by limiting the release of aqueous species due to the formation of stable secondary solid forms (see Fig. 1). Despite a large number of studies focused on NMs behaviour in synthetic exposure media, environmentally-relevant laboratory experiments assessing the behaviour of NMs in natural waters are less documented. As solid-phase transformation is strongly depending on intrinsic (particle-specific) and extrinsic (environment-specific) parameters, information on the transformations of NMs should then be addressed using experimental approaches, mimicking environmental conditions.

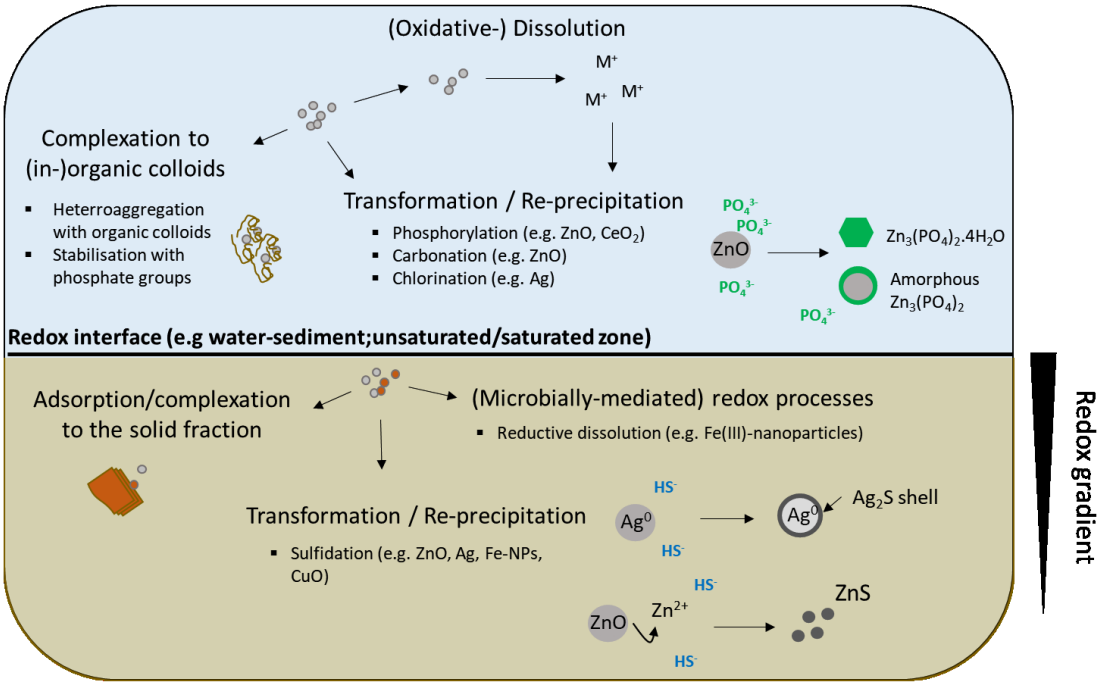

Figure 1: Conceptual illustration of transformations that NMs can undergo in the aquatic environment (i.e. surface waters, soils, and sediments.

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Description of Work

The overall goal of Work Package 2.7 (WP 2.7 "Abiotic Transformation of Nanomaterials in Environmental Aquatic Media") is the generation of information on the diversity of geochemical transformations of NMs likely to occur in aquatic environments. This includes both surface waters and sub-surface freshwaters. Such work aims to support the development of an OECD guidance document on environmental (abiotic) transformations of NMs. The objectives of D2.20 are (1) to give an overview of geochemical transformations of NMs likely to occur in aquatic environments, (2) to identify the major driving forces affecting the behaviour of NMs in natural waters, and (3) to define environmentally-relevant chemical composition of artificial media suitable to assess the transformation of NMs in specific aquatic environments. Finally, conclusions of this evaluation will be considered for the development of suitable experimental approaches and conditions for the testing of NMs transformations in risk assessment studies.

Main Results

The assessment of NMs transformations in aquatic systems can be first anticipated using the existing knowledge. However, knowledge on transformations of NMs in the environment still needs to grow and methods to assess such environmental questions still need to be improved, from their applicability to NMs to the attention of keeping representative scenarios of natural environments. Dissolution behaviour needs to be carefully assessed for NMs. However, determination of the nature of the end product is also crucial, since solid-phase transformations are likely to occur in all aquatic compartments and since most NMs dissolution would also act as an intermediate process leading in the formation of secondary species that could mitigate or increase the risk associated to an NM. It appears also necessary to have such speciation information to feed predictive models.
In a first step, to create relevant scenarios of NM exposures in natural waters, the range values of dominant hydro-chemical parameters affecting NM's behaviour in stream waters and anoxic pore waters have been identified. Based on this work, environmentally-relevant exposure media are proposed.

Summary

This deliverable D2.20 presents an overview of (abiotic) transformations that nanomaterials (NMs) can undergo in the aquatic environment. Based on existing database research on geochemical compositions of European Surface waters and specific rivers, e.g. Danube, Rhine, and Elbe, and literature research, the range values of dominant hydro-chemical parameters affecting NM's behaviour in stream waters and anoxic pore waters have been identified and various exposure media compositions for the testing of NMs have been proposed.

For more details about the Gov4Nano project please visit the Gov4Nano website. Public deliverables will be made available in due time via this website.