Comparative evaluation of methods to quantify dissolution of nanomaterials

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TU244 Comparative evaluation of methods to quantify dissolution of nanomaterials N.B. Hartmann, S. Kruse, A. Baun, Technical University of Denmark DTU / DTU Environment. Effects and behaviour of nanomaterials in the environment depends on the materials' specific physical and chemical properties and for certain nanomaterials (e.g., Ag, ZnO and CuO) aqueous solubility is of outmost importance. The solubility of metals salts is normally described as a maximum dissolved concentration or by the solubility constant (Ksp). For nanomaterials it is essential to also assess solubility kinetics as nanomaterials will often not dissolve instantaneously upon contact with artificial aqueous media or natural waters. Dissolution kinetics will thereby influence their short and long-term environmental fate as well as laboratory test results. This highlights the need to evaluate and improve the reliability of methods applied to assess the solubility kinetics of nanomaterials. Based on existing OECD guidelines and guidance documents on aqueous dissolution of metals and metal compounds, the aim of this project was to conduct systematic experiments contributing to a better understanding of how nanomaterials solubility can be tested and evaluated under the auspice of the OECD framework. The focus was to evaluate the performance of three different techniques used to separate the dissolved and non-dissolved fraction of nanomaterials, namely: dialysis membranes (MWCO 8-10 and 50 kD), Diffusive Gradients in Thin films (DGT) and ultracentrifugation. The release of Cu ions from CuO nanoparticles (primary nominal size < 50nm) was used as a case study. Micron sized CuO was used as a "non-nano reference" and CuSO4 and CuCl2 were used as ionic Cu references. In a comparative study of the three methods we found a good reproducibility between replicates and a good recovery (88-99% of nominal concentrations). However, we observed a large difference in results between the three applied methods. Preliminary results showed that by using the DGT method the measured dissolved fraction was 5-7 times higher compared to using ultracentrifugation and dialysis membranes. Possible explanations include metal-specific interactions with the dialysis membranes as well as the DGT unit influencing the dissolution equilibrium by acting as a ‘sink’ for Cu ions. These are issues that require further investigations. Based on these first results we would recommend ultracentrifugation as the most suitable method as it also offers the advantage of being ‘material-independent’ when correctly adjusted for particle sizes and density.