Mobility of Quantum Dots in soil at environmentally relevant conditions

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The environmental fate of Quantum Dots (QDs) after their release in soils will be dependent on several parameters including their chemical composition or their organic coating properties. In particular, the initial aggregation state at which the QDs enter the soil is likely to play a major role in determining their mobility and persistence. As such, limitations of previous studies include the use of homoaggregated nanoparticles, that may not represent their aggregation state when they enter the environment, and the use of concentrations much larger than those expected in soils on the basis of QDs-containing products life-cycle assessment.

In the present study we investigated the transport of CdSe/ZnS QDs nanoparticles in artificial soil columns at environmentally relevant pH and ionic strength. Quartz sand was selected as the porous medium, and calcium nitrate as the eluent. Two types of QDs of identical inorganic structure but different organic coating were investigated, TGA-QDs (thioglycolic acid) and POAMA-QDs (polyoctadecene-alt-maleic anhydride). The QDs were introduced in the column either as dispersed nanoparticles, or as aggregates. Further analysis included the spiking of QDs enriched in stable isotopes (e.g. ^{111}Cd) in order to decrease the detection limits and study the transport at more environmentally relevant concentrations (i.e. in the low μg/kg range).

Analysis of the leachate solutions and soil extracts by ICP-AES and HR-ICP-MS show that the QDs are predominantly retained in the column. However, the coating is an important factor controling their mobility and dissolution. These results are further confirmed by FEG-SEM analysis coupled with EDX. In general, dispersed nanoparticles display less deposition than the agglomerated species. Once into soil, the dissolution of deposited QDs was difficult to determine because of the dissolved species retention in the column by sorption or precipitation processes.