Radiolabelling of engineered nanomaterials as a tool for sensitive particle tracking

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Engineered nanoparticles (NPs) are present in a wide variety of consumer products, occasionally in significant quantities. During aging, abrasion or disposal of such products, NPs-release is likely - accompanied with effects for the environment that have to be investigated in more detail. The aim of this study is to quantify the amount of NPs (TiO_2 and Ag^0) released from composite coatings due to weathering, aging or mechanical stress and to follow the NPs along their further fate in the environment.

Generally, particle tracking may provide information on the transport behavoir of the particles in aqueous media or on their interactions with biota. Since NPs are possibly released in tiny amounts and into very complex natural systems, we suggest the radiolabelling of NPs as a tool for their very sensitive detection throughout their life cycle including complex media such as aquifer sands, soil or cells.

Within this study, a novel radiolabelling technique for TiO_2 (P 25, Evonik Degussa) and Ag^0 (Sigma-Aldrich) NPs is under development. During this labelling process, significant changes of the chemical composition and properties of the particles are avoided to the greatest possible extend.

Stability of the NPs in different media has been studied and results contribute to first estimates concerning their transport behaviour in the aquatic environment. Batch tests including sediment materials were conducted to describe interactions of Ag^0 and TiO_2 NPs with natural matrices.

Interactions of engineered NPs and natural colloids have been studied as well. Results show that natural colloids have a strong influence on stability and transport of engineered NPs under environmental conditions.

Based on these data, radiolabelling of engineered NPs may open up the chance for sensitive tracking of particles not only in environmental media but also in other complex systems.

How precisely can we date climate/ocean instabilities of the Last Interglacial?

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We examine here how precisely climate and environmental events of the Last Interglacial (LI) can be correlated and/or dated. For example, the SPECMAP chronology, often used for correlations (e.g., through stable isotope stratigraphies) cannot be linked to any given time series without taking into consideration: i) the specific lag times of Earth system components to insolation at a given latitude, ii) feedback processes between these components. As a matter of fact, the SPECMAP chronology and the timing of changes in the paleocean mass, salinity and isotopic composition, should unavoidably be in offset up to a few thousand years. In addition, neither geochemical signatures, nor the ocean volume, respond linearly to mass transfers into the hydrosphere (ocean/glaciers). A fortiori, adding tectonics, geoidal anomalies, site specific morphological responses to relative sea-level (RSL) changes and littoral activity, one may conclude that any direct attempt at correlating "RSL records" is risky. Finally, one cannot assume an equilibrium state of the Earth and its oceans, neither any probability of a "return" to a given state (i.e., the Earth is always in a no-analogue situation). Fortunately, the LI falls within U-series time control. Most other geochronometers lack precision (OSL, fission track) or are not necessarily applicable to relevant time series ($^{40}Ar/^{39}Ar$). If analytical techniques now permit to calculate ^{230}Th-ages with a fairly high precision, a large array of intrinsic limitations still prevail. For example, closed chemical systems are rarely secured in geological samples and there is no way to assess this closure with the degree of precision required to estimate age differences of the order of $\sim10^3$ yr. Furthermore, uncertainties in our present knowledge of the U-series decay constants already result in an age uncertainty of about ±1250 years (2σ) within MIS age ranges. Thus, one must conclude that unequivocal correlation of proxies documenting millennial frequency, climate/ocean instabilities of the last interglacial remains out of reach, but in exceptional cases and short intervals (Blake paleomagnetic event, tephra events). In a similar fashion, most processes which are critical for the understanding and modeling of the immediate future of the Earth climate/ocean system are within the error bars/stochastic noise of the paleo-records.