A Kinetic Environmental Fate Model for the Risk Assessment of Engineered Nanomaterials

RUTE F. DOMINGOS[1,*], JENNY P. HOLMBERG[2], MARIANNE MATZKE[3], EGON DUMONT[3], RALPH VANHAUTEN[4], CLAUS SVENDSEN[3], STEPHEN LOFTS[3], VIRGINIE KELLER[3], GEERT CORNELIS[2,5]

[1]Institut de Physique du Globe de Paris, 75238 Paris, France (rdomingos@ipgp.fr)
[2]University of Gothenburg, Kemivägen 10, SE 41296 Göteborg, Sweden
[3]NERC Centre for Ecology and Hydrology, United Kingdom
[4]ThinkWorks LLC, 2629 HD Delft, The Netherlands
[5]Swedish University of Agricultural Sciences, Box 7014, 75007 Uppsala, Sweden

An integrated exposure model is proposed for the prediction of the environmental fate of nanomaterials (NMs) in natural and man-made compartments. A semi-mechanistic approach is used, wherein the kinetic nature of the NM fate processes takes focus. Environmental matrix interactions depend on NM properties and relevant parameters, such as organic matter and ionic conditions, and are calculated on a temporal scale in each compartment. The obtained NM bioavailability is then linked with the hazard information. The goal of this approach is to apply the model for most currently-produced and possible future NMs, aiming to find a compromise between mechanistical accuracy and operational simplicity.

The current kinetic model gives fate descriptors for soil, surface water, sediment and wastewater treatment plants, and includes rates for key processes such as dissolution, sulfidation, heteroaggregation, and sedimentation. The time-dependency of chemical species concentrations is essential to link exposure scenarios with hazards that change over time, which is critical in assessing NM bioavailability and eventual risks.

This kinetic fate model is a key component in a web-based tool for the assessment and management of risks associated with NM-enabled consumer products, under the GUIDEnano Project (EU FP7). This work is also part of the NanoFASE Project (EU H2020).