Transformation of copper-based nanomaterials in soils

ADAM LAYCOCK[1*], BRIGITTE GERSTMANN[1], NATHALIE TEPE[1], MELANIE KAH[1], THILO HOFMANN[1] AND FRANK VON DER KAMMER[1]

[1]University of Vienna, Department of Environmental Geosciences, Vienna, Austria
[*]adam.laycock@univie.ac.at

The application of copper-based pesticide and biocide formulations in farming has been common practice for many years leading to steadily increasing copper concentrations in soil. The use of nano-enhanced formulations has been proposed as a means of increasing the efficacy and/or decreasing the copper dosage to agricultural land. However, this raises questions and concerns over the risk/benefit analysis and how to assess any environmental risk posed by such materials. Nano-enhanced copper-based pesticide and biocide formulations are one of the first applications whereby potentially large quantities of industrial nanomaterials would be intentionally released into the environment. It is therefore important to have a good understanding of their behaviour in order to be applied effectively and responsibly. This behaviour includes the mobility and bioavailability for plant uptake as well as the transformation into ionic copper species of different secondary forms of copper nanoparticles

The detection, quantification and characterisation of engineered nanomaterials once they enter complex natural matrices is notoriously difficult, especially for nanomaterials made from ubiquitous elements such as Cu and in matrices containing high concentrations of natural colloidal material such as soils. Here we show methods on how stable colloidal extracts were prepared from soils (obtaining the water-dispersible fraction of natural and engineered nanoparticles and colloids) and how subsequent analysis by conventional and single particle ICP-MS enabled the detection and characterisation of engineered copper-based nanomaterials.

These methods have been used to investigate how the number and size distribution of extractable copper-based nanomaterials varies with increasing soil incubation time. For this work standard LUFA soils were dosed with a range of copper-based nanomaterials, salts or pesticide formulations and were incubated for 0-31 days. Our results provide information on the transformation and persistence of the nanoparticulate fraction of these materials. This and similar studies can help fill knowledge gaps regarding the environmental behaviour of these materials and help to inform environmental risk assessments and aid in the safe and effective use and design of future nano-enhanced agrochemicals.