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Effects of multi-walled carbon nanotubes on mineralization and mobility of nonylphenol and sodium dodecyl sulfate in agricultural soils

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Nanotechnology is one of the major scientific research fields in this decade. One of the most wide-spread nanomaterials are carbon based nanoparticles (CNPs) which are increasingly be used in industry. Several studies shows that CNPs are interacting with other chemical compounds and organic pollutants in the environment. It is assumed that the interactions between CNPs and organic pollutants are affected by solution and aggregate behavior. Based on the knowledge of the behavior of CNPs and organic pollutants in aquatic systems the interactions of CNPs and organic pollutants in agricultural soils have to be studied.
As organic pollutants two environmental substances, nonylphenol (NP) and sodium dodecyl sulfate (SDS) were selected as model substances. They occur frequently in aqueous systems and also show different solubility behavior. As CNP representatives, two different multi-walled carbon nanotubes (MWNT) were selected. They differed either in length or outer diameter. Conclusions therefrom are to be closed the influence of length and diameter of the sorption capacity of different organic pollutants. In addition, two agricultural soils (sandy and silty soil) and one forest soil (sandy soil) were chosen.
Mineralization and sorption experiments were conducted to provide information about the degradation of organic pollutants in presence of multi-walled carbon nanotubes in soils. To analyze the CNPs mineralization potential, peroxidase activity was measured. Further extraction experiments were conducted to detect the extractable part of organic pollutants.
The results show that the surface area of the MWNT has a significant impact on the sorption behav-ior of NP and SDS in soils. The sorption of NP and SDS is much higher than without MWNT. However, the properties of the organic pollutants (different water solubility and hydrophobicity) are equally important and should be noted. The degradation of both pollutants is influenced by MWNT. Due to the strong sorption of NP and SDS on the MWNT, the degradation of these pollutants in soils, is slower than without MWNT. The peroxidase activity did not contribute to NP and SDS degradation. But the peroxidase activity in agricultural soils is higher than in forest soils. The extractable fraction of NP and SDS is very low and amounts to a maximum of 2 %.
Due to the lower degradation of NP and SDS in the presence of MWNT a longer retention of the substances in the soils and potential toxic effects for humans and animals, as a result of plant uptake may be taken into account.