Technical University of Denmark

Polymer coated gold nanoparticles for tracing the mobility of engineered nanoparticles in the subsurface

Uthuppu, Basil; Fjordbøge, Annika Sidelmann; Caspersen, Eva; Broholm, Mette Martina; Jakobsen, Mogens Havsteen

Published in:
Geophysical Research Abstracts

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

Geophysical Research Abstracts
Vol. 16, EGU2014-**PREVIEW**, 2014
EGU General Assembly 2014

Polymer coated gold nanoparticles for tracing the mobility of engineered nanoparticles in the subsurface

Basil Uthuppu (1), Annika Sidelmann Fjordbøge (2), Eva Caspersen (2), Mette Martina Broholm (2), and Mogens Havsteen Jakobsen (1)

(1) Department of Micro- and Nanotechnology, Technical University of Denmark, Kgs. Lyngby, DENMARK (mogens.jakobsen@nanotech.dtu.dk), (2) Department of Environmental Engineering, Technical University of Denmark, Kgs. Lyngby, DENMARK (mmbr@env.dtu.dk)

Nanoparticles (NPs) are manufactured for their specific properties providing possibilities for new and improved products and applications. The use of engineered nanoparticles (ENPs) has therefore brought significant innovation and advances to society, including benefits for human health and the environment. At the same time, little is known about the potential risk associated with the inevitable release of these new materials to the environment, and their new properties are poorly understood . Suspensions of ENPs are not very stable, as they tend to aggregate thereby losing their properties as single particles. Coatings, including a large variety of natural and synthetic polymers, are used to enhance the colloid stability in high concentrations . However, increasing the stability of these materials may lead to unintended effects, such as enhancing their mobility in surface water and groundwater leading to inadvertent impacts on aquatic ecosystems and human health. Detection of ENPs in natural water systems, however, has proved very challenging. Hence, there is a need for tracing of ENP behaviour in the environment.

We suggest a possibility of introducing inert gold NPs with the same mobility as the reactive NPs, as tracer particles. Colloidal gold has been of great interest for centuries due to its vibrant colors produced by the interaction with visible light. The unusual optical-electronic properties, high chemical stability and relatively low toxicity have made them the model system of choice in this context. Also, the natural occurrence of these particles in the proposed environment is very rare. Laboratory based experiments conducted in sand columns show that stable aqueous suspensions of gold NPs coated with amphiphilic block co polymers (PVP-VA and PVA-COOH) are extremely mobile (retardation factors of 1.0-1.2) with high recovery values (50-95 %). The specific retardation and recovery depends on the coating type, concentration and grafting method. The NPs also show significant partitioning to organic phases such as tetrachloroethylene (PCE) and trichloroethylene (TCE), which are considered as potential ground water pollutants accumulated in the subsurface as DNAPLs (dense non-aqueous phase liquids). Being a noble metal, nanogold is to be detected by nondestructive optical methods at a concentration of at least 1000 fold lower than ENPs. Using conventional spectrophotometric technique equipped with liquid waveguide capillary cell (LWCC), nanogold is detected at very low concentration range (1 ppm – 62.5 ppb). Compared to uncoated particles, surface modified nanogold with polymers retains the plasmonic peaks at 520 nm when diluted with artificial ground water.

Acknowledgement: The low level detection of nanogold using LWCC was done at the department of nuclear and quantum engineering, KAIST (Korea Advance Institute of Science and Technology), 291 Daehak-ro, (373-1, Guseong-dong), Yuseong-gu, Daejeon 305-701, Republic of KOREA. We acknowledge Prof. Woojin Lee, Prof. Jong-Il Yun, Kim A Young and Tae Hyeong Kim for the same.