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Discovery may help manage nanoparticle wastes from consumer products

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A new discovery about nanoparticle behaviour in sewage treatment plants could improve the environmental management of nanoparticle wastes from foods, cosmetics, medicines, cleaners and personal care products.

Scientists from the Centre for Ecology & Hydrology (CEH) and the Science & Technology Facilities Council's ISIS Neutron Source, along with colleagues from King's College London and Oxford University, have studied how certain nanoparticles behave in wastewater and identified a way to potentially help remove them during primary sewage treatment. The scientists examined silica nanoparticles which are commonly found in consumer products and routinely discharged to wastewater.

The study, published in *Environmental Science & Technology*, simulated primary sewage treatment to show that coating silica nanoparticles with a detergent-like material (surfactant) made the nanoparticles interact with components of the sewage to form a solid sludge. This sludge can be separated from the wastewater and disposed of. In contrast, uncoated nanoparticles stayed dispersed in the wastewater and were therefore likely to continue through the effluent stream.

Each year manufacturers worldwide use over one million tonnes of silica nanoparticles in consumer products. A large proportion of these are washed down the drain into the sewage system. This makes sewage treatment plants a major gateway for nanoparticles to enter the aquatic environment.

"Our research shows that primary sewage treatment may not be effective at removing some nanoparticles. However, we now know where those nanoparticles may go and how we might deal with them," said Dr Steve King from the ISIS Neutron Source.

The scientists used the ISIS Neutron Source to view the sewage at the nanometre scale. Nanoparticles are too small to be seen by the human eye. The ISIS Neutron Source is like a giant microscope, enabling scientists to study objects 1,000 times thinner than a human hair. The neutrons easily penetrate the turbid sewage and scatter strongly from the nanoparticles, allowing the aggregation behaviour of the nanoparticles to be measured through time.

Dr Helen Jarvie from CEH said, "The research proves that the surface chemistry of nanoparticles influences their likely removal during primary sewage treatment. By adding a coating which modifies that surface chemistry, it may be possible to re-route their journey through sewage treatment plants." She added, "Further work is now planned to examine the behavior of a wider range of nanoparticles, with different classes of

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Further information

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Images of the ISIS facility and the lead scientists are available to journalists. A cartoon drawing depicting the experimental results is also available.

Notes

1. The research will be published in the November issue of *Environmental Science & Technology*: 'Fate of Silica Nanoparticles in Simulated Primary Wastewater Treatment'; Helen P Jarvie, Hisham Al-Obaidi, Stephen M King, Michael J Bowes, M Jayne Lawrence, Alex F Drake, Mark A Green and Peter J Dobson.

2. This research was funded by the Natural Environment Research Council under the Environmental Nanoscience Initiative (grant NE/E014585/1). The STFC ISIS Facility funded construction of some of the apparatus used in the experiment and provided neutron beam time.

3. ISIS is a world-leading centre for research in physical and life sciences operated by the Science & Technology Facilities Council at the Rutherford Appleton Laboratory, Didcot, Oxfordshire, UK. ISIS supports an international community of over 2,000 scientists who use neutrons and muons for research in physics, chemistry, materials science, geology, engineering and biology. It is the most productive research centre of its type in the world.

4. Neutron scattering is a vital research and analysis technique in exploring the structure and dynamics of materials and molecules. It provides unique and complementary information to that available from synchrotron light sources.

At ISIS, a synchrotron accelerator speeds a proton beam to 84 percent the speed of light before it is fired at a small tungsten target to make neutrons. The neutrons released from the target are then channelled along evacuated beampipes into the material being examined.

Neutrons have no electric charge and penetrate deep inside materials. By looking at how neutrons scatter off the atoms inside materials, they reveal the atomic structure of the material under study. This enables researchers to correlate the structure of materials with their properties and understand how they behave in different circumstances.

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5. The Centre for Ecology & Hydrology (CEH) is the UK's Centre of Excellence for integrated research in the land and freshwater ecosystems and their interaction with the atmosphere. CEH is part of the Natural Environment Research Council and employs more than 450 people at five major sites in England, Scotland and Wales with an overall budget of about £35m. CEH also hosts over 150 PhD students. CEH tackles complex environmental challenges to deliver practicable solutions so that future generations can benefit from a rich and healthy environment.

6. The Natural Environment Research Council (NERC) funds world-class science, in universities and its own research centres, that increases knowledge and understanding of the natural world. It is tackling major environmental issues such as climate change, biodiversity and natural hazards. NERC receives around £400m a year from the UK government's science budget, which is used to provide independent research and training in the environmental sciences.

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