Researchers produce tiny nanoparticles and reveal their inner structure for the first time

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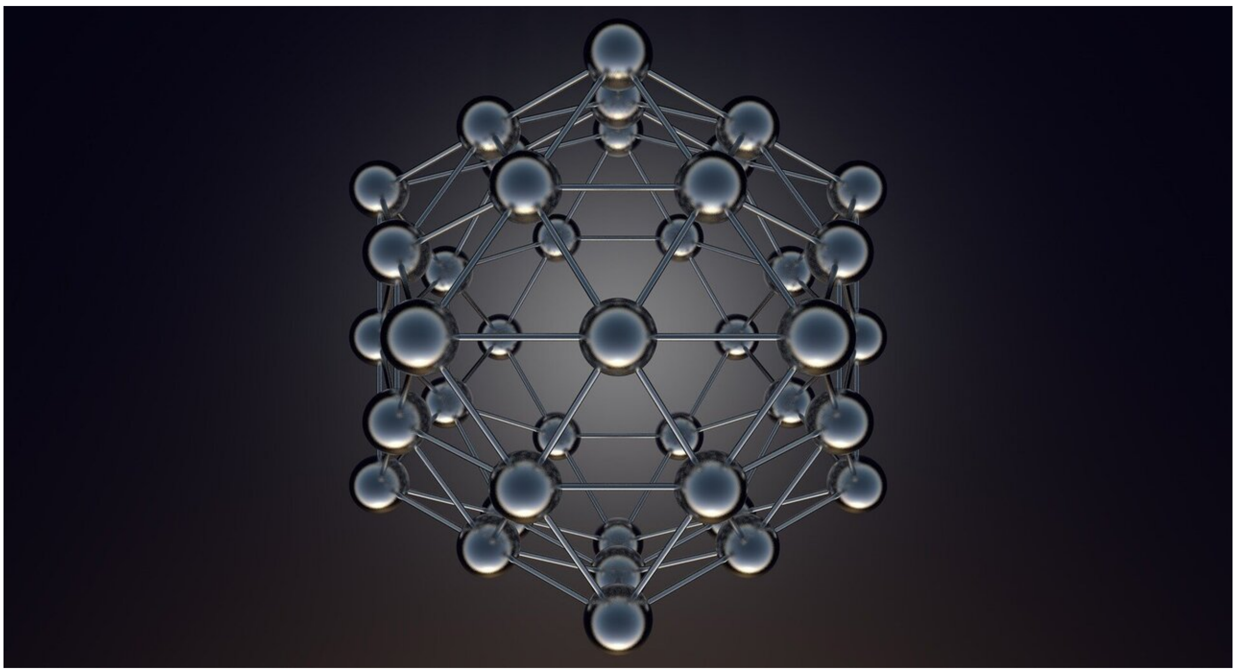

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Tiny nanoparticles can be furnished with dyes and could be used for new imaging techniques, as chemists and physicists at Martin Luther University Halle-Wittenberg (MLU) show in a recent study. The researchers have also been the first to fully determine the particles' internal structure. Their results were published in the renowned journal *Angewandte Chemie*.

Single-chain nanoparticles (SCNPs) are an attractive material for chemical and biomedical applications. They are created from just a single chain of molecules that folds into a particle whose circumference measures three to five nanometres. "Because they are so small, they can travel everywhere in the human body and be used for a wide variety of purposes," says Professor Wolfgang Binder from the Institute of Chemistry at MLU. As it is a new area of research, some questions still remain unanswered. Up until now, for example, the inner structure of the particles had only been assumed, but not finally resolved.

After Binder and his team developed new single-chain nanoparticles that could be used in medicine, they wanted to know more about their structure. "We concluded that the nanoparticles we developed must have a special, internal structure," says Binder. To establish this, he contacted colleagues from the departments of chemistry and physics at MLU. Using a combination of electron spin resonance and fluorescence spectroscopy, the scientists were able to visualize the structure of an SCNP for the first time. "They form a kind of nano-pocket that can protect a dye or other molecules," explains Binder. Their findings are in line with previous assumptions about the possible spatial structure within such tiny particles.

The aim of Binder's research group is to develop nanoparticles for diagnostic testing. However, producing the nanoparticles is a complex task. "They have to be virtually invisible to the body," explains Justus Friedrich Hoffmann, a Ph.D. student in Binder's research group. They cannot be destroyed by the body's immune system and they must also have the right internal binding sites so that a dye or another molecule can be stored and protected. In addition, they have to be water-soluble so that they can be transported via the bloodstream. "They often form large clumps, but we have now been able to produce individual particles," says Hoffmann. They used a chemical trick to condense the chain into the desired form.

The dye, which is incorporated during the manufacturing process, is to be used for so-called photoacoustic imaging. The procedure represents an alternative to computer tomography but without the dangerous radiation. It allows one to look several centimeters deep into tissue from outside the body. Normally the dye is quickly destroyed by the body, says Binder. The tiny nanoparticles protect the dye, which could be used, for example, in the visualization of tumors which it would enter via blood vessels.

SCNPs can be used in a wide variety of other applications, too. For instance, they could be used as nanoreactors in which chemical reactions take place.

More information: Justus F. Hoffmann et al, Fluorescent and water dispersible single-chain nanoparticles: core-shell structured compartmentation, *Angewandte Chemie International Edition* (2020). DOI: 10.1002/anie.202015179

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