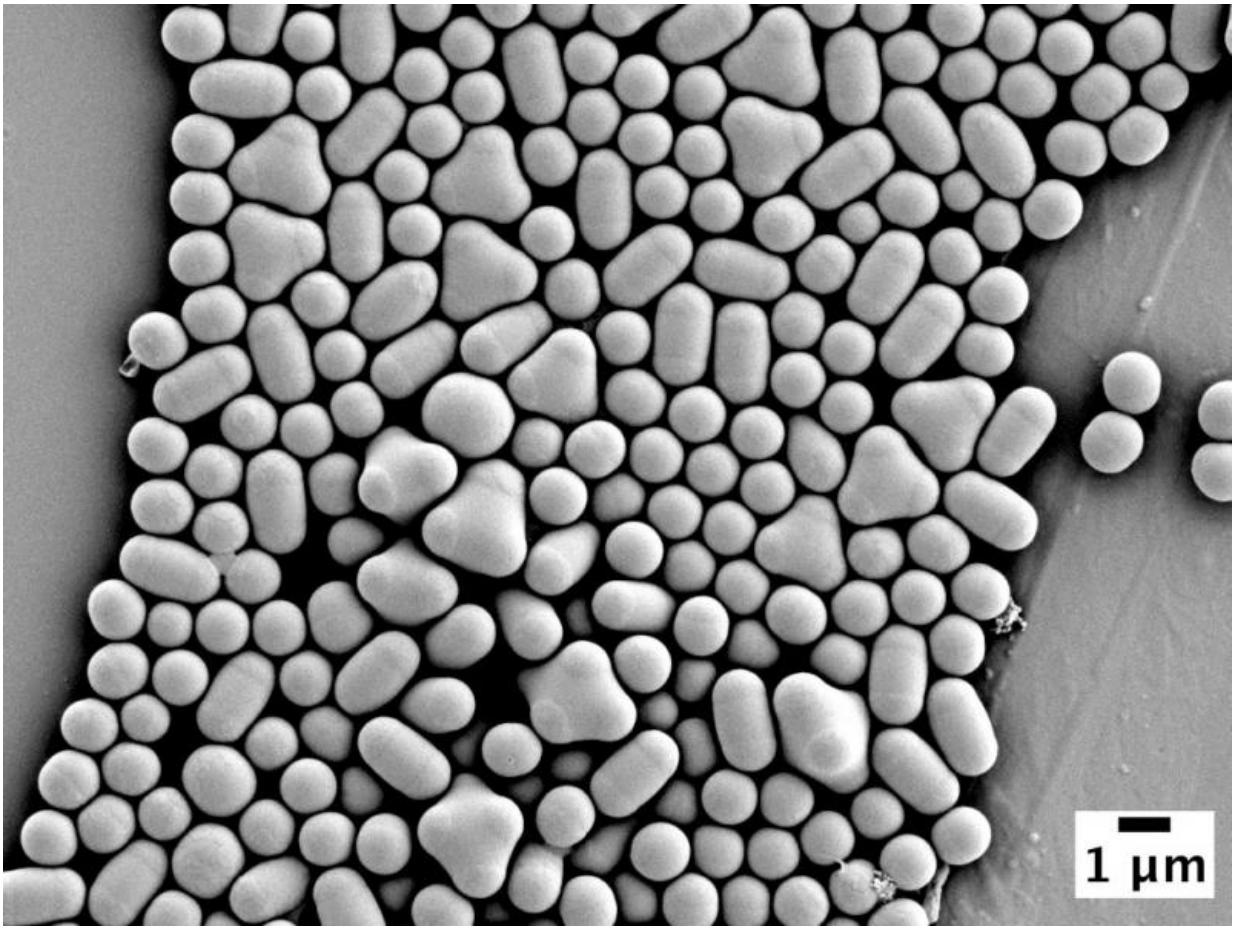
Using colloids to build complex structures

April 6 2016, by Erik Arends



When researchers add oil to colloidal clumps, the particles recycle themselves into uniform complex base structures. All clumps containing 2 particles form dumbbell shapes, 3 particles form triangle shapes and 4 particles make up tetrahedron, like we see in this electron microscopy image. Credit: Leiden Institute of Physics

Manufacturers produce high-end technology mostly top-down with large machinery, but small particles can build structures from the bottom up. A major challenge is that these particles easily clump together. Leiden physicist Daniela Kraft has developed a method to take advantage of this phenomenon. She has published her results in *ACS Nano*.

Building blocks

Smaller computer chips, narrow sound boxes, miniature cameras; we keep aiming for smaller and more complex technology, to carry with us or for applications like surgery. At the same time, it is increasingly difficult to build complex components on increasingly smaller scales. Thus, it could be much more convenient to build structures from the bottom-up, using tiny building blocks. That is the pursuit of the research group of Leiden physicist Daniela Kraft. She is working on a method to build structures from colloids— particles that are larger than nanoparticles but too small to see with the naked eye. Interestingly, colloids operate completely on their own, as independent building blocks.

Chunks

This field of research is still in its early stages, but Kraft and her Ph.D. student Vera Meester have now made a giant leap forward by developing a method to use a large barrier to their advantage. "Colloids have a strong tendency to clump together," says Kraft. "Normally, that is bad news, but we let them go ahead and make sure that they rearrange into a desired structure afterwards."

Control

They control the building process by adding salt or oil to the colloidal

solution at specific times. This enables them to control the attractive Van der Waals forces and the surface tension. Under the influence of these forces, the randomly shaped chunks swell and reconfigure in a specific way. The type and concentration of salt and oil determine which structures the colloids form. By testing different combinations, Kraft now knows how to create a number of basic structures, from a simple dumb-bell shape to a pentagonal dipyramid. "Theoreticians have already predicted what kinds of useful larger structures we can build with these basic building blocks, but in practice, you never know what is actually going to happen."

Medical robots

Once physicists have obtained sufficient knowledge about how to command colloids to build specific structures, they will bypass the limit that manufacturers approach from their top-down approach by going the other way: bottom-up. In this way, they'll be able to fabricate miniature devices that currently beyond the reach of conventional industry. Kraft says, "In the future, we might build tiny light switches or medical robots. Because we work bottom-up, we won't be limited with respect to complexity, materials or length scales."

More information: Vera Meester et al. Colloidal Recycling: Reconfiguration of Random Aggregates into Patchy Particles, *ACS Nano* (2016). DOI: 10.1021/acsnano.5b07901

Provided by Leiden Institute of Physics