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## Nanosheets made by mimicking protein formation

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Unravelling the complex process by which nanoparticles self-assemble into microscopic wafers could lead to new techniques for building nanoscale devices.

One of the most important challenges facing nanotechnology researchers is controlling the way nanoscopic particles assemble into useful structures.

Researchers have already found that some particles will assemble into wires or simple 3D structures under the right conditions. Until now, however, making simple sheets from nanoparticles has proven particularly tricky. It has normally involved forcing particles to assemble on top of a liquid or at the interface between two different mixtures.

Nicholas Kotov at the University of Michigan, US, noticed that cadmium telluride nanocrystals spontaneously form sheets 2 microns thick if submerged in water. He and colleague Sharon Glotzer performed experiments and computer simulations to figure out precisely what was going on.

### Complex interactions

It turned out that a complex set of interactions cause the sheets to form. The simulations reveal that this very closely mimics the way some proteins form tiny sheets.

To begin with, each nanocrystal is partially coated with a surfactant, which is left over from the process used to grow the crystals. Those parts of the crystals coated with surfactant are hydrophobic, and tend to want to stick to one another. But uncoated parts are hydrophilic, and prefer to be surrounded by water. Each nanocrystal is also a dipole, like a bar magnet, and has a positive charge.

"It's a complicated combination of these forces," Glotzer says. "If all you had was hydrophobic and hydrophilic interactions, the crystals would still aggregate into something. But it wouldn't necessarily be sheets."

### Protein formation

The process is similar to one employed by a protein found in bacteria to form sheets known as S-layers, which form the outermost layer of a cell.

The work could prove useful for scientists trying to build nanoscale devices. Knowing exactly how the cadmium telluride forms these sheets could enable them to manipulate other nanoparticles so that they do the same thing, Glotzer says.

"Once we know how to manipulate the forces between the nanoparticles, and their ability to self-organise, it will

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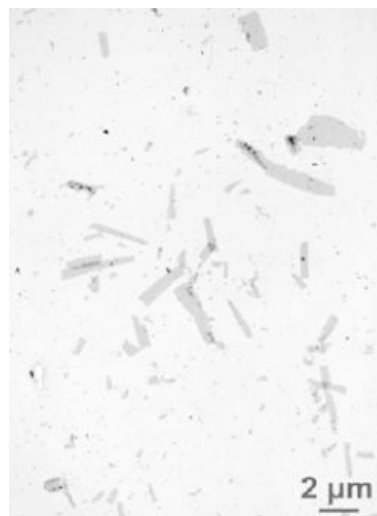
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The nanosheets form sheets in a similar way to proteins found in bacteria (Image: Science)

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nanoparticles and their ability to self-organise, it will help us in a variety of practical applications," Kotov says, "from light-harvesting nanoparticle devices to new drugs which can act like proteins, but are actually nanoparticles."

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