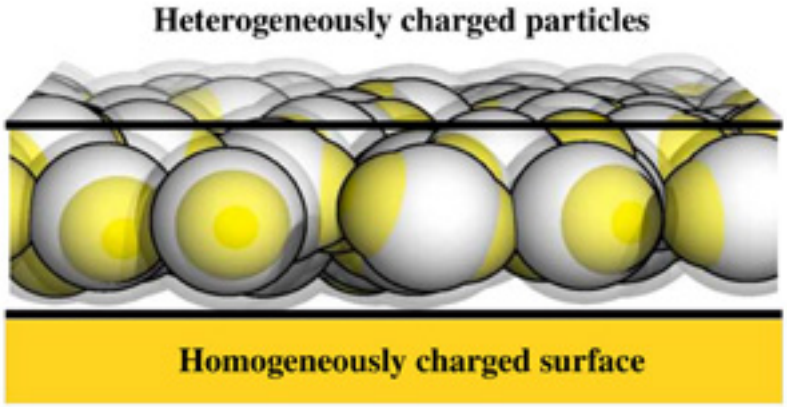
Discovery sheds light on how to control self-assembly process

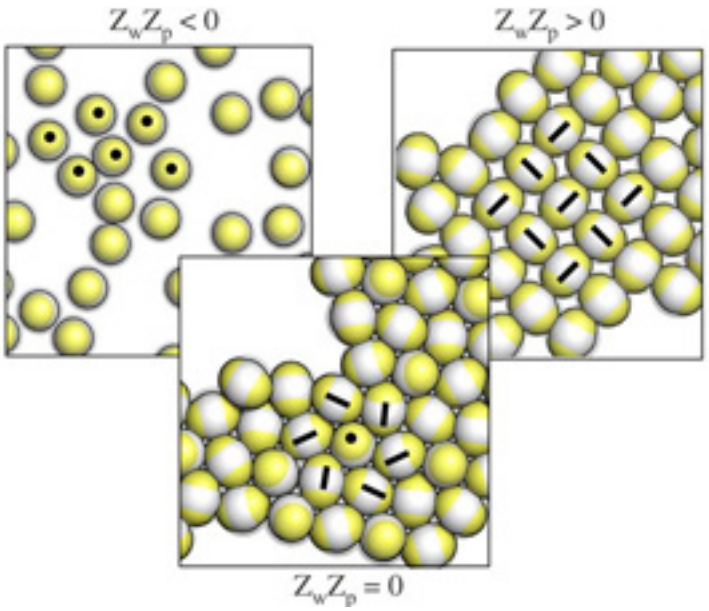


Imagine a tower that builds itself into the desired structure only by choosing the appropriate bricks. It sounds absurd, but in the nano world this is now reality: There, a disordered crowd of components can initiate the formation of an ordered structure in a process known as self-assembly. Physicists Christos Likos (University of Vienna), Emanuela Bianchi and Gerhard Kahl (both Vienna University of Technology) have been investigating how they can control the ordering of self-assembling structures and discovered how to switch the assembly process on and off. The results are now published in the journal *Nano Letters*.

Materials with specific properties at the nano-and micro-scale level are heavily sought after due to the broad spectrum of applications in electronics, photovoltaics and biomimetic material synthesis. For many synthesis applications, mesoscopic crystalline structures are needed. Scientists have to deal with the challenge of developing reliable, efficient and cheap methods to produce target structures with specific symmetries and physical properties. Nowadays, rather than relying on externally-controlled tools, most of the fabrication methods are based on the self-assembly of care fully chosen or synthesized base units. The macroscopic counterpart, such as building a tower or a bridge, can be accomplished in the nanoscale realm just by choosing the appropriate bricks and letting them self-organize into the desired structure.

In the vast realm of functional nano-and micro-scale materials, the realization of mono-and bi-layer assemblies on surfaces is of paramount relevance to the recent research in Austria. Low-dimensional systems with well-defined features have applications such as anti-reflection coatings, biosensors, data-storage, optical and

photovoltaic devices, or catalysts. The properties of materials synthesis' strongly depend on a delicate balance in between the properties of the assembling units and those of the underlying surface.



Researchers in Vienna focused on nano-units with a complicated surface pattern, consisting of regions with different surface charge. The investigated units are mostly negatively charged with the exception of the positively charged polar regions on the top and at the bottom of the particles. Similar non-homogeneously charged units appear either in biosystems, such as viral capsids and proteins, or in experimentally synthesized systems, such as virus-like nanoparticles, nano-cubes and spotted vesicles covered with specific metals.

In the recent paper they focused on the self-assembly of the described heterogeneously charged particles in the vicinity of a homogeneously charged substrates. Their computer simulations showed how complex structures at the nanoscale level can spontaneously emerge and how it is possible to reliably control the ordering of the particles into specific, quasi-two-dimensional aggregates. Depending on different parameters, such as the particle or wall charge and the extension of the charged regions on the particle surface, the units created can form surface layers with different densities (and possibly different responses to external stimuli). Sometimes particles assembled into close-packed, hexagonally ordered crystalline aggregates, sometimes they formed open, square-like layers, and sometimes they do not assemble at all.

The work investigated the variety of the self-assembled structures offered by the chosen bricks and characterized the specific collective behaviors of these structures, depending on how the relevant parameters of the synthesis system is tuned. Most importantly, they showed that subtle changes of either the pH of the solution or of the electrical charge of the substrates makes it possible to reversibly switch the assembly process on and off as well as to induce a transformation from a one specific spatial or orientational arrangement to another.

Tunable Assembly of Heterogeneously Charged Colloids [1]

Source: University of Vienna [2]

Links:
[1] http://pubs.acs.org/doi/abs/10.1021/nl500934v
[2] http://medienportal.univie.ac.at/presse/aktuelle-pressemeldungen/detailansicht/artikel/nano-world-where-towers-construct-themselves/