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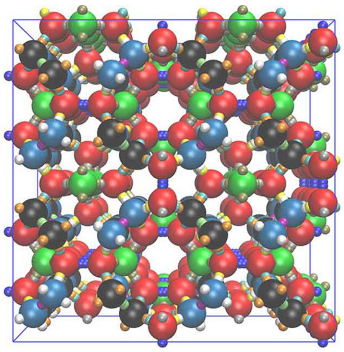
Scientists program "patchy" particles to assemble like puzzle pieces into complex crystal forms.



The vital question of how to design particles to assemble into a chosen structure plays an important role in materials design. Assembling colloids into target crystal structures is expected to lead to favorable photonic structures that can be used to manipulate light in useful ways. Engineering these particles into complex crystalline forms is no easy feat.

To understand how to assemble particles in certain ways, Tracey et al. theoretically studied "patchy" particles to observe their interactions and how they make connections. Like puzzle pieces coming together, the assembly of patchy particles have short-ranged interactions that can only occur when the patches on adjacent particles are aligned.

The authors developed a scheme to assemble patchy particles into a target crystal structure. Their goal was to design a scheme that worked for any target crystal structure, however complex.

The researchers took advantage of the torsional component of the patchy particle interactions, which permits them to connect only when they have the correct relative orientations. They introduced this component to control the form of the complex structures.

"One could say we have programmed into the particles instructions for what structure they will self assemble into," said author Jonathan Doye. "This was achieved by having multiple particle types and attractive interactions that were both directional and specific to a given pair of particle types."

Tracy et al. successfully applied their patchy particle design scheme to five different complex structures.

"For us, this project is a stepping stone towards an even more challenging goal, namely, designing particles that could form quasiperiodic structures, particularly icosahedral quasicrystals, which thus far have only been observed experimentally in metallic alloys," said Doye. "We are making good progress in this direction."

Source: "Programming patchy particles to form complex periodic structures," by Daniel F. Tracey, Eva G. Noya, and Jonathan P. K. Doye. *Journal of Chemical Physics* (2019). The article can be accessed at https://doi.org/10.1063/1.5128902.