Molecular Solomon's Knot

December 15 2006

It has been a beloved symbol for centuries, prized as an ornament found in engravings and embroidery, mosaics, and tattoos—and now as a molecule: Solomon's knot, a motif consisting of two doubly intertwined rings.

A team of researchers from the University of California, Los Angeles (USA), and Nottingham Trent University (UK) have now used a self-organization process to get molecular building blocks to weave themselves into a Solomon-type knot. "The secret of our success is the careful selection of metal ions and solvents," revealed J. Fraser Stoddart in the journal *Angewandte Chemie*. "Although various molecular species compete with each other in solution, the Solomon's knot wins out during the crystallization process simply because it crystallizes better."

Systems consisting of individual molecular components that are not chemically bound to each other, but rather are tied together through purely mechanical means, are an enormous challenge for scientists. Stoddart, one of the pioneers in the area of supramolecular chemistry, has successfully produced a whole series of such structures.

For example, he and his team have produced a system of molecules in the form of Borromean rings, whose name is derived from an Italian family that used such interlocked rings in their crest. Stoddart's Borromean rings are formed from an 18-component self-assembly process in which six organic pieces with two "teeth" and another six with three "teeth" grip six zinc ions, producing the mutually interlocked three ring system.

Things get particularly interesting when zinc and copper ions are mixed in a 1:1 ratio: a 12-component self-assembly process ensues to interlock two rings twice over instead of three, resulting in the formation of a molecular Solomon knot, isolated upon crystallization. The four loops of the knot are stabilized by two copper and two zinc ions. In solution, there is initially an equilibrium between the different types of knots. During crystallization, the Solomon's knot form is preferred over the Borromean rings.

"In the making of these exotic compounds, chemical bonds are being broken just as fast as they are being formed until the compound that feels the most comfortable emerges as the final product," explains Stoddart.

Citation: J. Fraser Stoddart, itle: A Molecular Solomon Link, *Angewandte Chemie International Edition* 2007, 46, No. 1, 218–222, doi: 10.1002/anie.200603521

Source: Angewandte Chemie

Citation: Molecular Solomon's Knot (2006, December 15) retrieved 13 May 2024 from https://phys.org/news/2006-12-molecular-solomons.html

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