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Artisan Molecules

Metal-terpyridine complexes form fractal polymers with aesthetic shapes

Steve Ritter

Molecular self-assembly has allowed chemists to become ever more creative by incorporating aesthetically pleasing patterns into the structures of macromolecules. In one of the latest examples, a team of chemists led by George R. Newkome at the University of Akron, in Ohio, has prepared a "Sierpiński hexagonal gasket," the first example of a molecule whose structure has a nondendrimer fractal pattern (*Science*, published online May 11, dx.doi.org/10.1126/science.1125894).

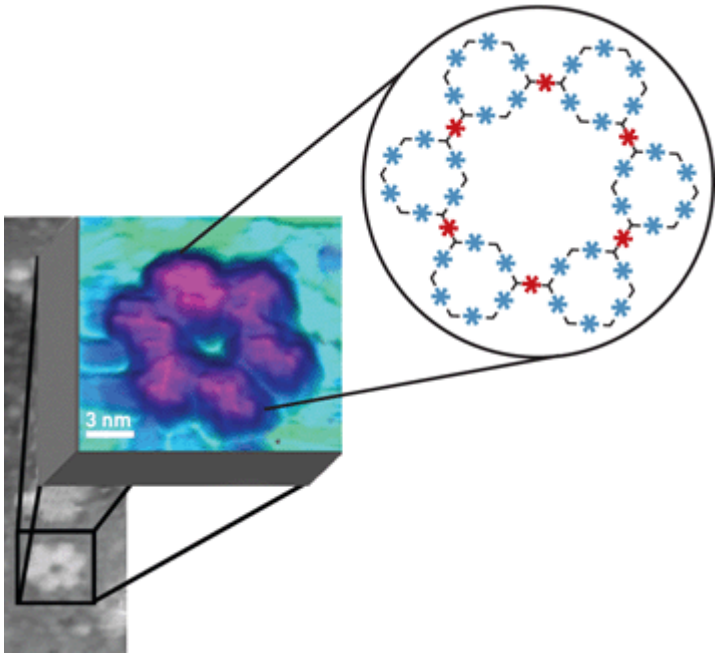
Fractals are mathematical constructs used to describe "self-similar" structural motifs, which appear similar at all scales of magnification. Some examples are snowflakes and tree branches, the latter pattern already well-known in chemistry from polyamidoamine and other dendrimers. The Sierpiński gasket, named after Polish mathematician Wacław Sierpiński (1882-1969), is a hexagonal array of hexagons. Sierpinski derived an equation that describes how the shape can be formed from a series of interrelated equilateral triangles.

Newkome and his colleagues mimicked the gasket pattern by inducing sets of ruthenium and iron bis(terpyridine) complexes to

self-assemble. They first built a hexagonal ring of six ruthenium complexes joined together by benzene rings. This hexamer has exposed terpyridine groups on two corners, and its reaction with $FeCl_2$ forms iron bis(terpyridine) complexes that lash the hexamers together into a larger hexagon.

Altogether, the synthesized gasket has 36 ruthenium complexes and six iron complexes. The gasket is large enough for the individual hexamers to be visible in scanning tunneling microscope images. Beyond the artistic value, fractal polymers have potential uses as magnetic and electronic materials.

The synthesis "moves dendrimers from being the unique member in the chemical fractal family to that of a subset of fractal materials," Newkome says. "In essence, we now have dendritic and nondendritic fractal polymers."



Adapted from *Science*

Gasket Weaving Sierpinski gaskets are visible in a micrograph, with a single gasket highlighted in a color-enhanced exploded view. Blue asterisks represent ruthenium bis (terpyridine); red asterisks, iron bis (terpyridine); the complexes are

coupled by benzene rings.

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