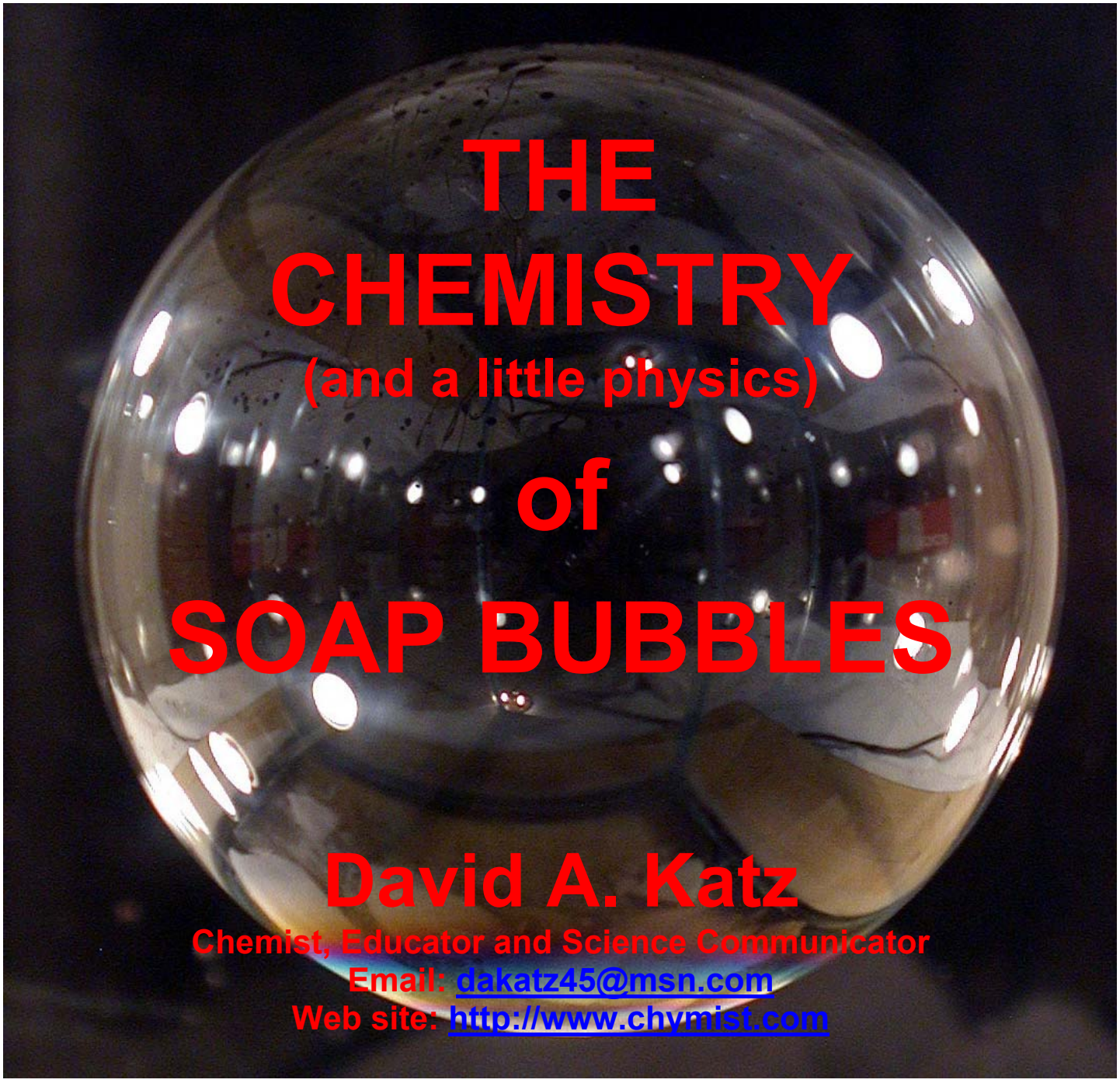

THE CHEMISTRY (and a little physics) of SOAP BUBBLES

David A. Katz

Chemist, Educator and Science Communicator

Email: dakatz45@msn.com

Web site: http://www.chymist.com

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David A. Katz
Chemist, Educator, Science Communicator, and Consultant
5003 Canby Drive
Wilmington, DE 19808, USA
Email: dakatz45@msn.com

Investigations with Soap Films and Frames

Some experiments with soap solutions, other than blowing bubbles, can be performed with different shaped wire frames dipped into soap solution. These frames can be purchased in kits, ready made, or they can be made by bending and twisting together stiff wire, such as a heavy gauge copper wire. (Stiff pipe cleaners can be used, but some tested by the author tended to sag when wet with the soap solution.) More permanent frames are made by soldering the wire together. Some shapes that can be used are shown in Figure 18.

To demonstrate the surface tension of a soap film (in addition to the method in Experiments 4 and 5, take a piece of thin string or thread, tie it into a loop, dip it in soap solution, and gently lay it on a soap film on a large simple loop. Using a dry toothpick, touch the soap film in the center of the string loop. What happens?

Using a loop within a loop, dip it into a soap solution to get a soap film in both loops. Use a dry toothpick or a dry finger and touch the soap film inside the center loop. What happens?

Using a planar rectangle with a movable side (see Figure 18), slide the side close to the bottom and dip it into a soap solution. Make sure your hands are soapy. Can you move the side up and down stretching and compressing the soap film? How much can the soap film be stretched?

Dip a cubic frame into a soap solution. What happens to the soap films on the cube? How many soap films are in contact at any one point? Can you measure the angles between the films?

You can put a bubble in the middle of a bubble frame. First, dip the bubble frame into soap solution and withdraw it. The soap films will not coat the outside of the frame, but they will tend to arrange themselves in a minimum surface area arrangement. Next, dip the cube about half way into the soap solution and withdraw it to put a bubble into the middle of the frame. Describe the bubble in the center of the frame. An alternative method of putting a bubble in the center of the frame is to use a soda straw, dipped in soap solution, to blow a bubble in the center of the minimum surface area arrangement of films in the frame. Using the soda straw, you can make the center bubble larger, by gently blowing into it, or smaller, by gently sucking some air out of the center of the bubble.

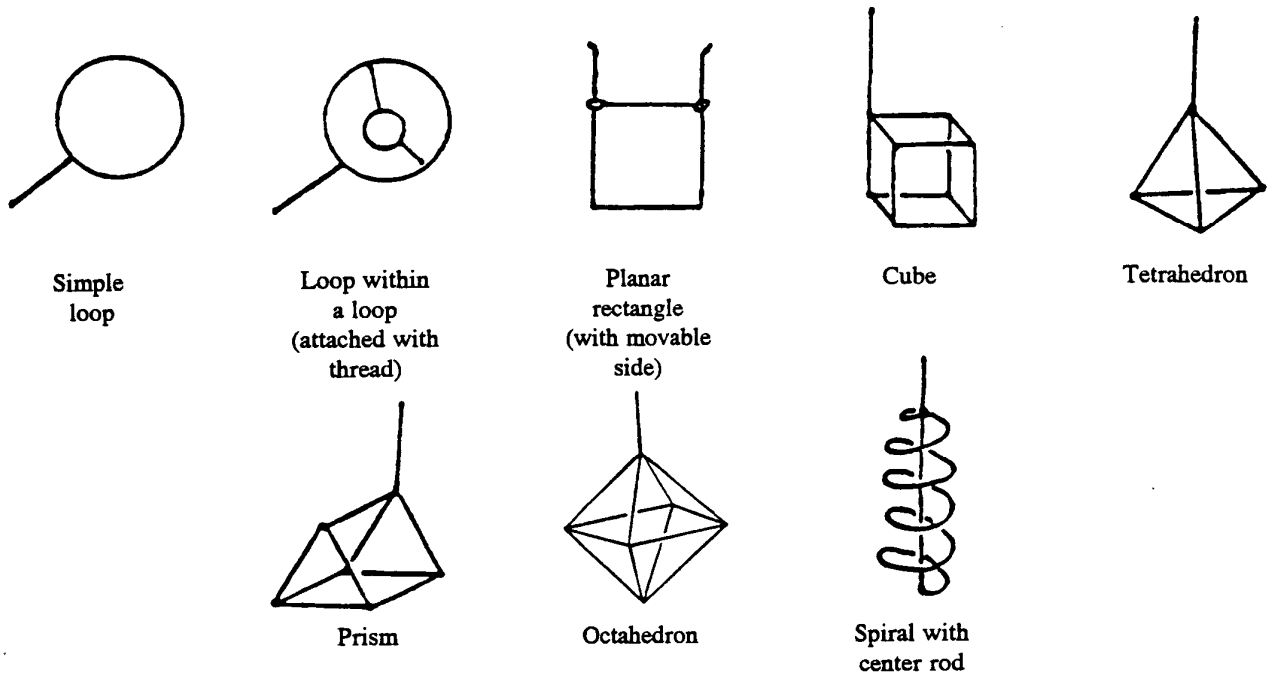


Figure 18. Different shaped wire frames for experimenting with soap films.

Dip a tetrahedral frame into a soap solution. What happens to the soap films on the tetrahedron? How many soap films are in contact at any one point? Can you measure the angles between the films? Dip the tetrahedron about half way into the soap solution and withdraw it to put a bubble into the middle of the frame. Describe the bubble.

Dip a triangular prism frame into a soap solution. What happens to the soap films on the prism? How many soap films are in contact at any one point? Can you measure the angles between the films? Dip the prism about half way into the soap solution and withdraw it to put a bubble into the middle of the frame. Describe the bubble.

Dip an octahedron frame into a soap solution. What happens to the soap films on the octahedron? How many soap films are in contact at any one point? Can you measure the angles between the films? Dip the octahedron about half way into the soap solution and withdraw it to put a bubble into the middle of the frame. Describe any bubbles that form in the center of the octahedron. Repeat your investigations putting bubbles inside the octahedron.

Dip a spiral frame into a soap solution. Describe the soap film that forms.

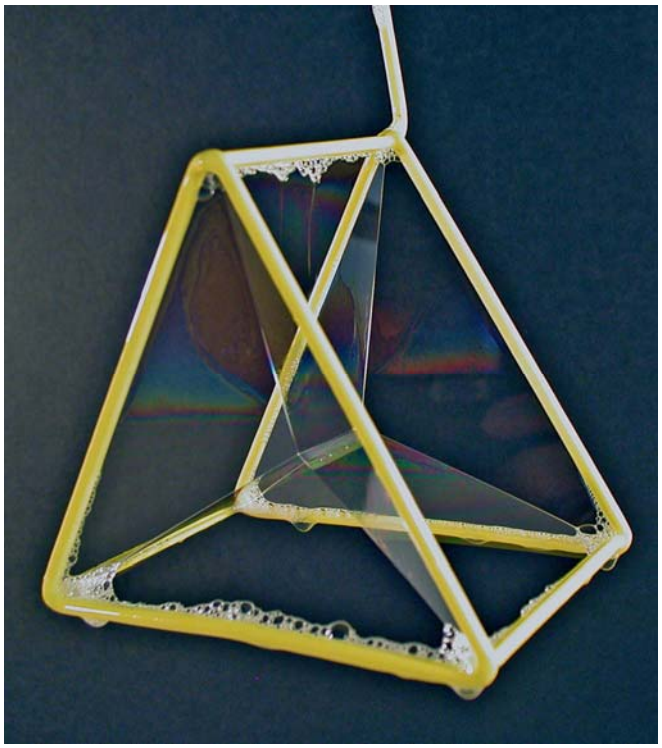
You can do further investigations by constructing different shaped frames using stiff wire. Use your imagination to come up with different shaped frames.

If you want to make frames more complex than those shown in Figure 9, then a different construction set is needed. One such set, tested by the author, is Zome System. This is a set of small spherical connectors, called nodes, and connecting rods that allows one to construct many

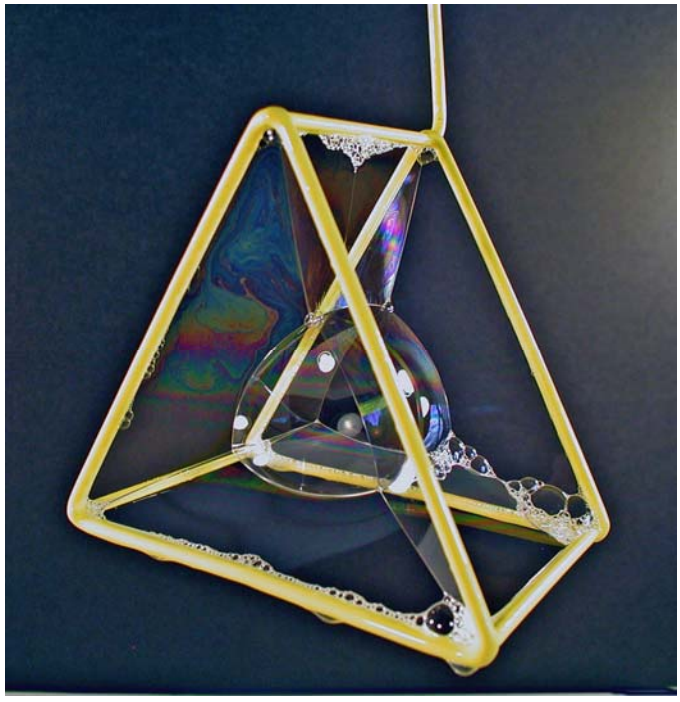
geometric shapes from cubes to octahedrons, decahedrons, dodecahedrons, and more. Shapes which, in the past, were too tedious to construct by joining and welding heavy wire are now possible with this construction system.

Photos with Soap Bubble Frames

A triangular prism frame produces soap films which meet on 3 sides at angles of 120° (The angles at the "corners" are 109.5°.)



When the triangular frame is dipped twice, a triangular prism bubble is formed.

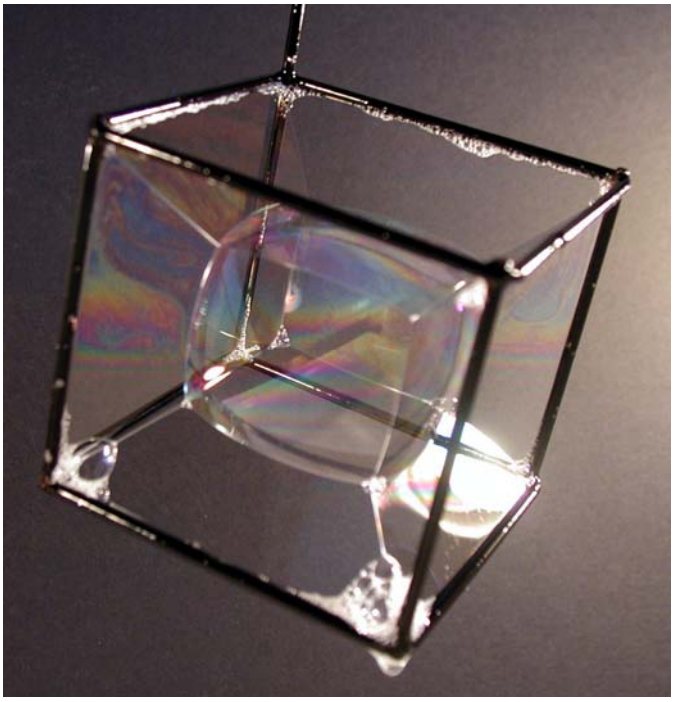


A tetrahedral frame produces soap films that meet at an angle of 109.5°

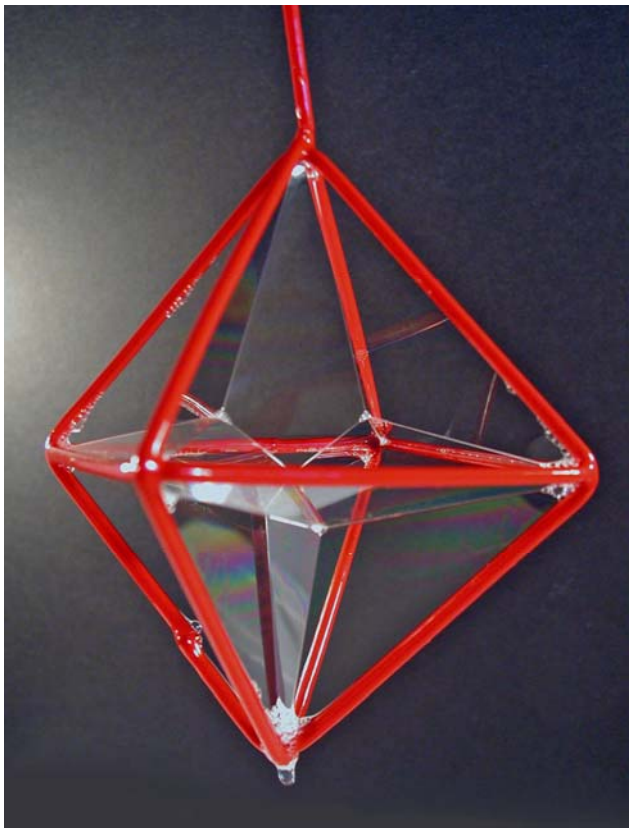
When the tetrahedral frame is dipped twice, a tetrahedral bubble is formed.

In a cubic frame, the soap films collapse toward the center of the frame. Angles between films is approximately 120° along edges and 109.5° at corners.

Dipping the cubic frame twice, the soap bubble in the center is stretched into the shape of a cubic bubble. Angles between films is approximately 120° along edges and 109.5° at corners



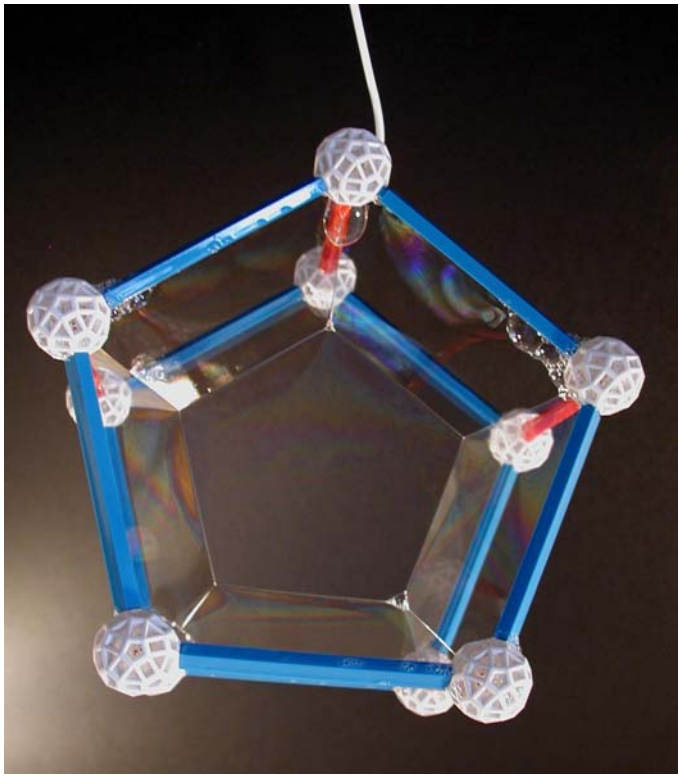
An octahedral frame has too many edges to form simple intersecting films at a single point.



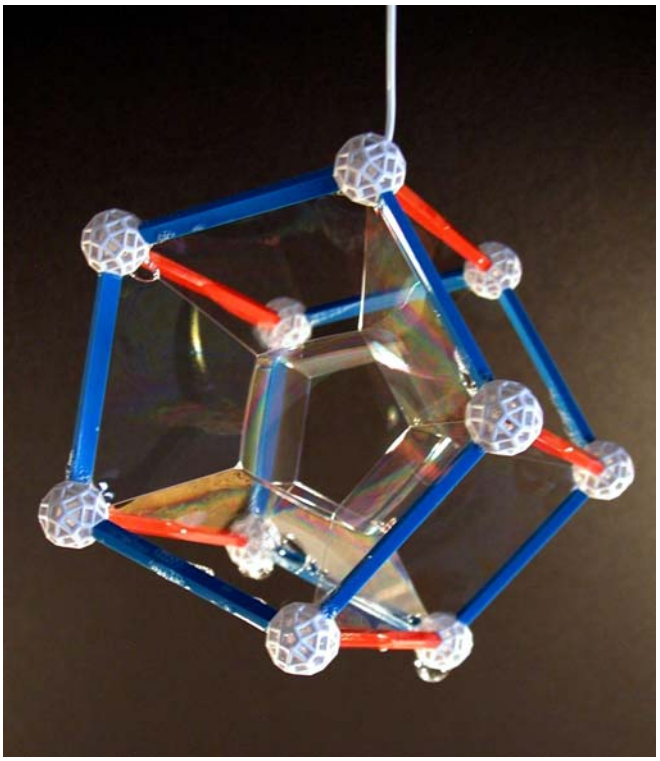
Due to the number of edges, it is difficult to form a single octahedral bubble in the middle of the frame. This is as close as I could get. Note that there are bubbles surrounding the octahedral bubble in the center.

A helical bubble frame must have a center shaft. A bubble film will not form on a free hanging helix.

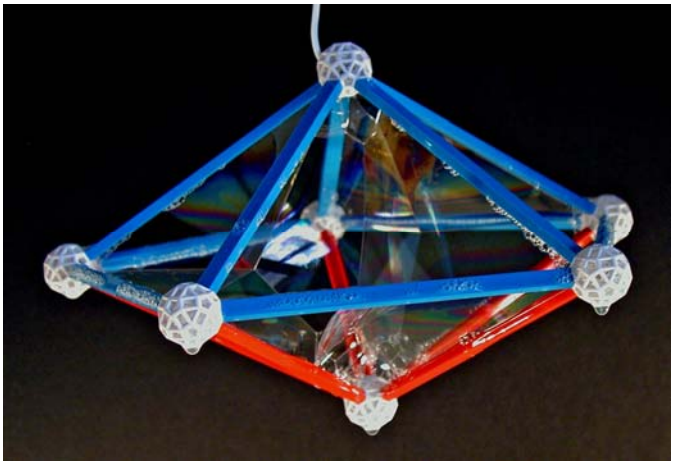
Using the Zome system, a pentagonal prism was constructed. A pentagonal film was formed in the center of the frame.



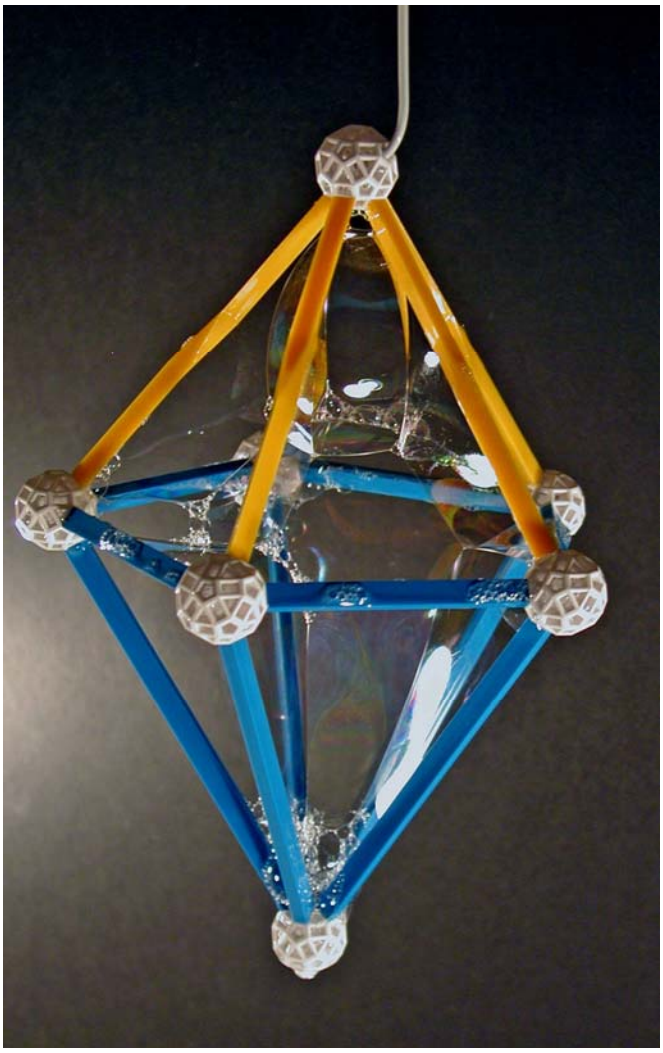
A second dip into the bubble solution formed a pentagonal bubble in the middle of the frame.



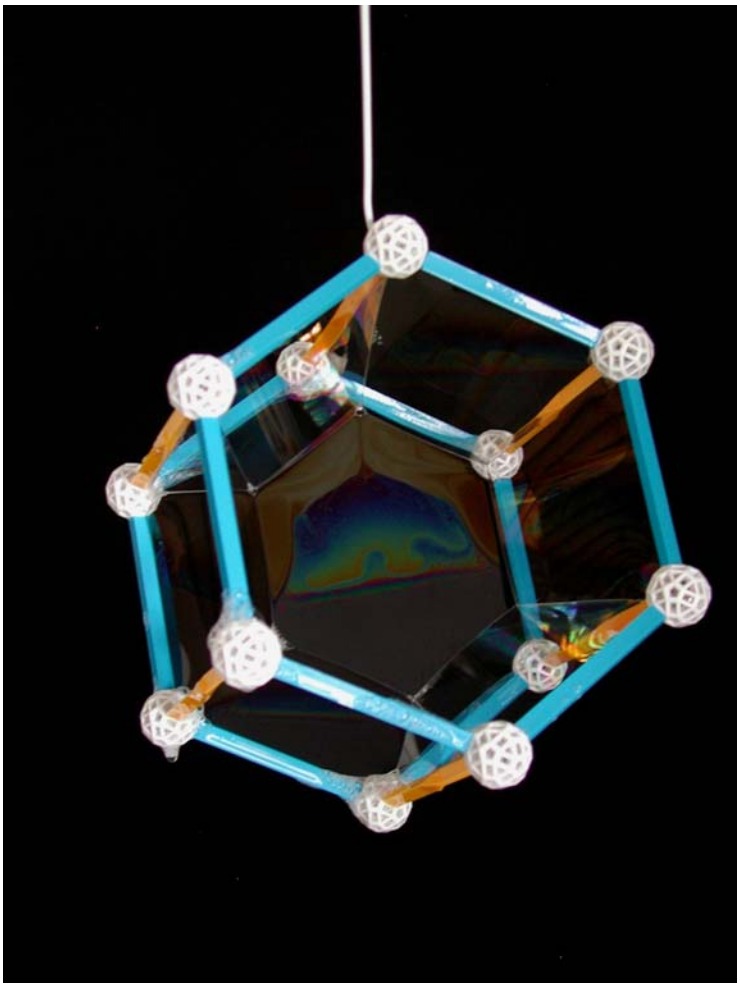
A pentagonal pyramid, like an octahedron, has too edges to maintain a single bubble in the middle. Some small bubbles surround parts of the central bubble



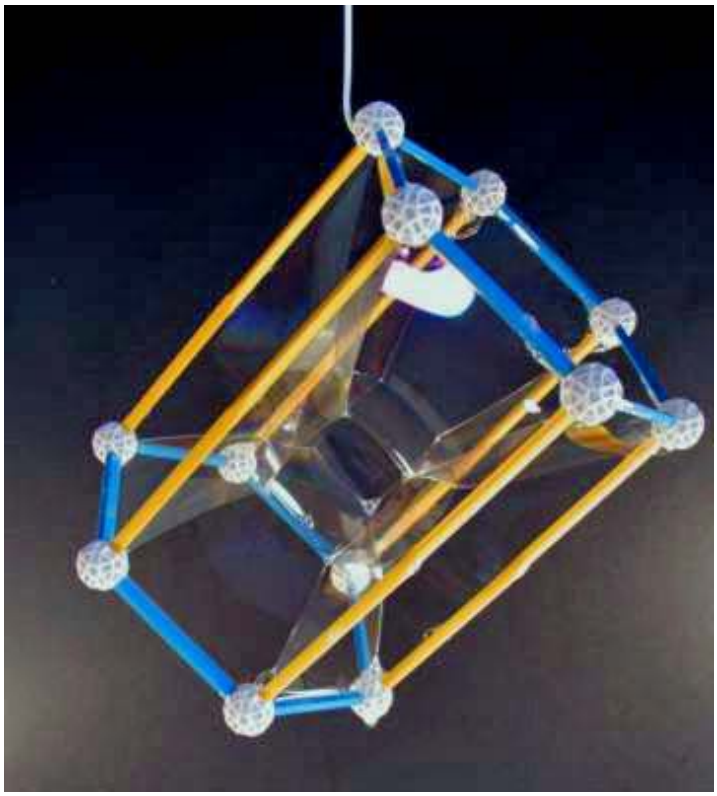
A pentagonal bypyramid is constructed by elongating the axis perpendicular to the pentagon. The bubbles around the central bubble are more pronounced in this structure.



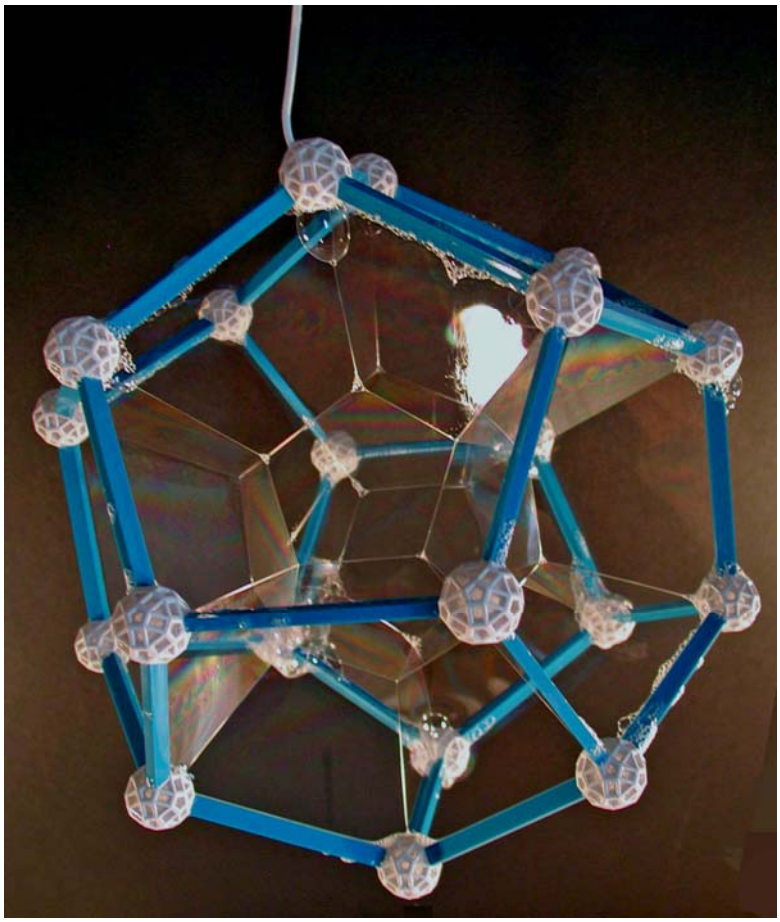
A hexagonal prism frame will form a hexagonal bubble film in the center.



A second dip of the hexagonal frame into the bubble solution produced a hexagonal bubble in the middle.



A dodecahedral bubble can be formed in the middle of a dodecahedral frame.



A square dodecahedron has too many edges to effectively form a single central film or bubble.