Chicken-Wire Buckyballs

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Abstract: A method for building models of C_{60} and C_{70} fullerenes from chicken wire is described. The flat, uncut chicken wire is representative of a sheet of graphite; therefore, the same medium may be used to compare these two allotropes of carbon.

Introduction

The much-celebrated fullerenes, or buckyballs, are the most recently discovered carbon allotropes. The most-studied fullerene, C_{60}, has a highly symmetrical structure that contains 20 hexagonal rings and 12 pentagonal rings of carbon atoms. These rings are fused into a 32-sided geometrical shape resembling the pattern of seams on a soccer ball, with each pentagon surrounded by 5 hexagons. The C_{70} fullerene is similar to the C_{60} fullerene, but C_{70} contains an additional five hexagons, giving it the shape of a prolate spheroid. By contrast, graphite, another allotrope of carbon, has a sheet-like structure with each flat sheet consisting of fused hexagonal rings of carbon atoms. Construction of models of fullerenes and graphite using conventional molecular modeling kits can consume large amounts of modeling kit materials; therefore, it is sometimes desirable to use alternate construction systems involving prefabricated polygons. The fused hexagonal rings in graphite are reminiscent of chicken wire [1], also referred to as rabbit fencing. This same chicken wire can be cut and bent to form the C_{60} and C_{70} structures, providing a comparison of fullerene and graphite structures. Fullerene structures may also be modeled with paper shapes [2–4], but the resulting closed structures tend to accentuate the empty pentagonal and hexagonal faces of the structure. The chicken-wire fullerenes can accentuate carbon–carbon connectivity with wires representing covalent bonds. The wire structures can also be placed on an overhead projector to show bond connectivity to large groups of students (see Figure 3 below). Directions for creating wire models of a C_{60} fullerene and a related C_{70} fullerene are given below. Doubtless, this technique could be extended to other fullerene structures and even to buckytubes, which can be described as having hemispherical fullerene caps at the ends of a rolled-up tube of graphite.

Procedure

Materials.
Chicken wire (or rabbit fencing)
Wire cutters
Needle-nosed pliers

Safety Precautions

Cut chicken wire can be sharp! Wear gloves to keep from being cut by the ends of the wires.

C_{60} Directions.

1. Using the wire cutters, cut the chicken wire to match the shape of the chicken wire in Figure 1.
2. Cut the wire in the locations indicated by the red lines in Figure 1.
3. Using the needle-nosed pliers, bend all the cut-wire ends downward.
4. Bring the wire ends that come off from the hexagon sides labeled A together and twist them together with pliers. Now, there should be one pentagon surrounded by 5 hexagons (see Figure 2).
5. Repeat step 4 for, in order, sides B, C, D, E, F, G, F, G, H, I, J, K (other orders will also work). For safety, bend all of the twisted ends so that they are pointing into the structure.
6. The final structure should be spherical and should resemble the model shown in Figure 3. All pentagons should be surrounded by five hexagons.

C_{70} Directions.

1. Using the wire cutters, cut the chicken wire to match the shape of the chicken wire in Figure 4.
2. Cut the wire in the locations indicated by the red lines in Figure 4.
3. Using the needle-nosed pliers, bend all the cut wire ends downward.
4. Bring the wire ends that come off from the hexagon sides labeled A together and twist them together with pliers. Now there should be one pentagon surrounded by 5 hexagons.
5. Repeat step 4 for, in order, sides B, C, D, E, F, G, F, G, H, I, J, K, L, M (other orders will also work). For safety, bend all of the twisted ends so that they are pointing into the structure.
6. The final structure should have the shape of a prolate spheroid and should resemble the model shown in Figure 5. All pentagons should be surrounded by five hexagons.

References and Notes

1. Holper, P.; Sarre, A. Buckyballs—a new sphere of science. http://www.science.org.au/nova/024/024key.htm (accessed Nov 2000).
2. Beaton, J. M. *J. Chem. Educ,* **1992,** *69,* 610–612.
3. Beaton, J. M. *J. Chem. Educ.* **1995,** *72*, 863–869.
4. Nakamoto, K.; McKinney, M. A. *J. Chem. Educ.* **2000,** *77,* 775-780.

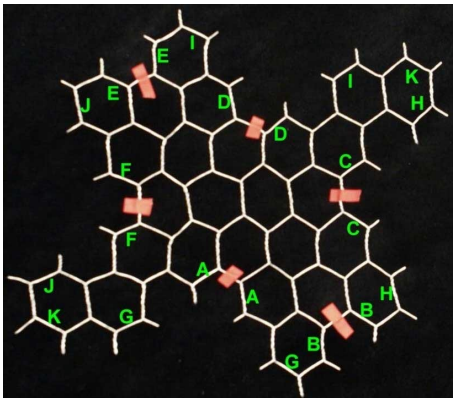

Figure 1. Flat wire pattern to be shaped into a C_{60} fullerene.

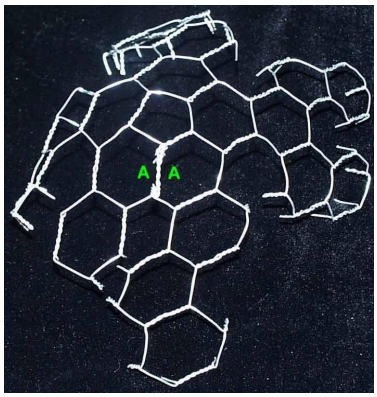

Figure 2. The hexagon sides labeled A are brought together and the dangling ends are twisted together; the result is the formation of a pentagon and the introduction of curvature into the structure.

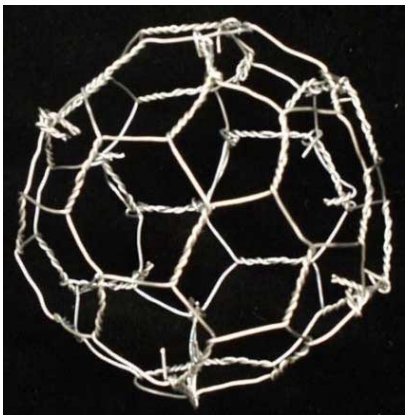

Figure 3. (A) The chicken-wire model of a C_{60} fullerene.

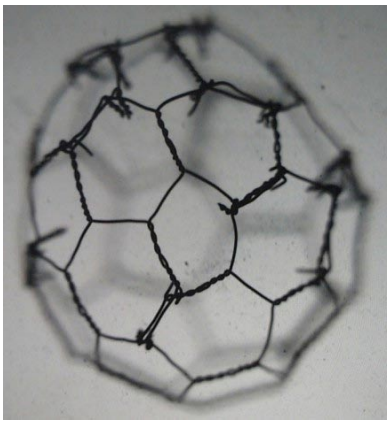

Figure 3. (B) The projected image of the model that has been placed on an overhead projector.

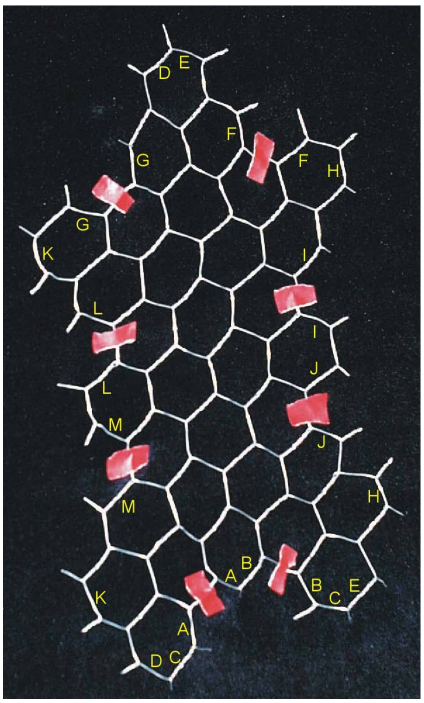

Figure 4. Flat wire pattern to be shaped into a C_{70} fullerene.

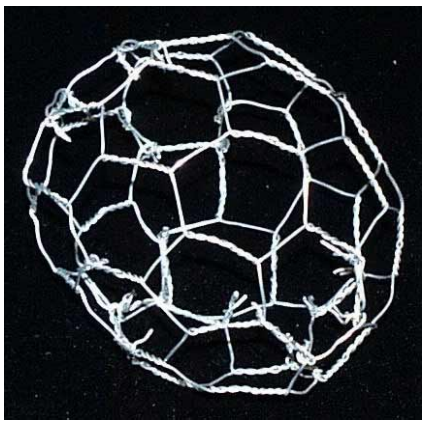

Figure 5. The chicken-wire model of a C_{70} fullerene.