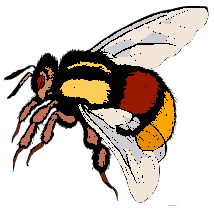
Dynamic Design: A Collection Process

Shaping Up

STUDENT TEXT

Bee's Wax



What shape did your team use for the wafers? What shape do you think the Genesis scientists used? Would it surprise you to know that they chose the same shape that bees use to make their honeycomb? The central structure of a bee's colony is the wax comb. It is made up of six-sided white wax chambers or cells. Keep in mind that the honeycomb is made by instinct and completely in the dark. After eating honey, the worker bees rest. As they rest, their wax glands begin secreting wax scales. The glands are located in their abdomen. When the wax is secreted, it is in liquid form, but hardens quickly. The light yellow wax is then moved to the anterior portion of the bee's body to the mandibles. The mandibles form the wax into shape for making a comb. More and more wax is made until the cell is done. The walls of the cell are thin, but the outer edges are thick. Hutchins, in his book *Insects,* states that this strengthens the cells so that the bees are not injured when they walk about over them. "Mathematicians have determined that the shape of the cells is such as to hold the largest amount of honey with the smallest amount of structural material. One pound of wax will build about 35,000 cells which will hold about 22 pounds of honey. They are built precisely, there being less than three or four degrees of variation in their angles." (Hutchins, 1966) The cells vary in size according to their purpose.

Go to: http://www.beloit.edu/~biology/zdravko/honey_comb.jpg for a picture of a honeycomb.

Shapes in Nature

Have you determined what shape it is yet? If you guessed a hexagon, you are correct. A hexagon is an example of a regular polygon, one whose sides are all the same lengths and whose angles are all the same sizes. "Pentagons and hexagons are (the) most numerous (polygons) at high densities, with the hexagon shape as the perfect packing method." (Grant, 1968; Buckley and Buckley, 1977) Both honeycombs and most of the Genesis wafers are examples of a regular tessellation. A regular tessellation is one where the polygons are congruent, the vertices of at least three polygons meet at each vertex point, and there are at least three angles around each vertex point. (See Figure 1) Can you name some other hexagons or tessellations found in nature? One example of a hexagon in organic chemistry is the benzene ring molecule, C_6H_6. A benzene ring contains six carbon atoms attached together with a hydrogen atom attached to each carbon atom. (See Figure 2)

Figure 1. Tessellation

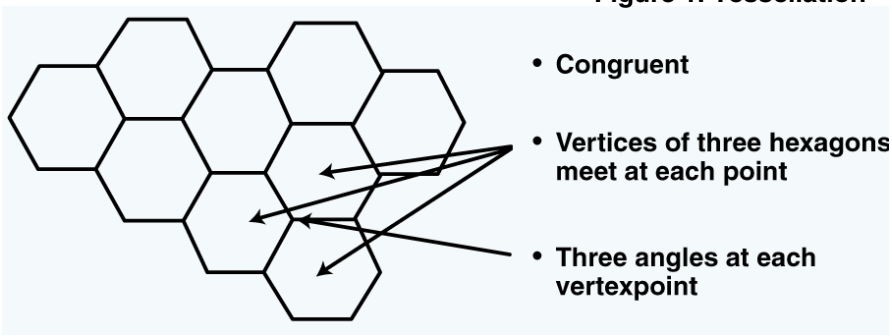
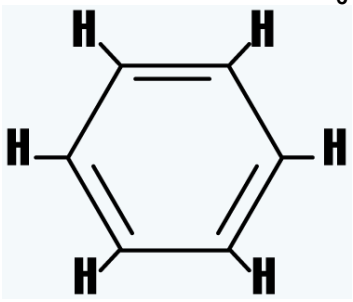


Figure 2. Benzene Molecule C_6H_6

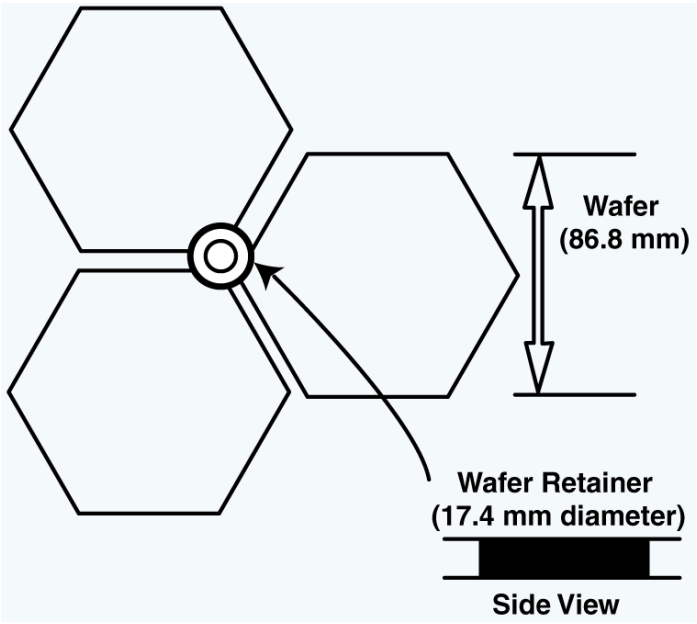


A carbon atom is at each corner of the hexagon.

Solar Wind Collector Wafers

The solar wind collectors are constructed from wafers made of very pure, very clean materials attached to an array frame. Most of the wafers are hexagon-shaped, though some are half-hexagons near the edge of the array. Hexagon-shaped wafers maximize the collection area and so allow it to nest close to its neighbor in the array. Most of the wafers are made from silicon, though some are aluminum and gold, diamond, and germanium. The wafers will capture and hold the solar wind samples. During the two year "sun bath," every element from lithium to uranium are implanted. All wafer materials that are exposed to the solar wind will collect all solar wind elements. The science team chose the following variety of materials as collectors because each has advantages during analysis. Back on Earth, the silicon wafers, which are between 0.4 and 0.6 mm thick, will be used to analyze most of the elements and isotopes. Chemical vapor deposited diamond will be used to analyze oxygen, nitrogen, and other light elements. Aluminum will be used for the noble gases. Diamond, gold/platinum, germanium and other substances will be used for the alkali and radioactive elements. The wafers are installed and held together with a circular wafer retainer. (See Figure 3) A better explanation of wafer assembly will be detailed in upcoming Genesis module *Dynamic Design: A Clean Room*.

Figure 3. Wafer and Retainer (not drawn to scale)



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Collector Arrays

There are five collector arrays that are 73 cm in diameter on the Genesis payload. Each array consists of 42 hexagon wafers and 13 incomplete hexagon wafers. The wafers are placed on the array so that there is one centimeter of space between them. There are four arrays stacked together in the container and one found on the lid. The lower stacked arrays are shaded from the solar wind when not in use. The top array and the one in the lid will be used to collect bulk solar wind (they will always be exposed). The bottom three in the stack will be used to collect specific regimes of solar wind. (See Figure 4)

Figure 4. Collector Arrays in Canister

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Collector Array: Note there are four arrays stacked on the left and one in the lid at right. This shows the arrays collecting bulk solar wind using the array on the lid and the top array at left.