Super Models

Graphite

Molecular Model Kit

Recommended for ages 10 - adult.

⚠ **Caution:** Atom centers and vinyl tubing are a choking hazard. Do not eat or chew model parts.

Related Kits Available:
Buckyball Molecular Model Kit
Buckytube Molecular Model Kit
Diamond Molecular Model Kit

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Kit Contents:
76 black 3-peg carbon atom centers (2 spares)
92 clear, 1.25″ bonds (2 spares)
6 white, 10cm rigid tubing (1 spare)

General Information

Allotropes are different forms of any one element. Carbon, is one of those elements that can be found existing, naturally, in a variety of allotropes.

These include 1) diamond, 2) graphite (stacked layers of graphene), 3) amorphous carbon (soot and charcoal), 4) fullerenes which can contain large numbers of carbon atoms arranged as spheres, ellipsoids, or tubes, and 5) several less common forms as well. Each allotrope has its own distinct chemical and physical property. The most stable form of carbon is graphite.

Graphite is composed of many layers of carbon atoms, each layer is called graphene. Each graphene layer in turn is made of carbon atoms arranged in hexagons. Each atom is sp^2 hybridized resulting a sheet of aromatic benzene rings sharing common sides. The pi electrons of the rings are very mobile, acting as good conductors of electricity across a layer, but not from one layer to the next.

The layering of graphite is described as ABA, which means that if three layers, or more, are observed, the next to the bottom-most layer is slightly offset so that the atoms of the two layers are not in register. However, the third layer is in register with the first layer, but not the second. See Figs 1 and 2 which show three layers of graphene in the ABA crystal structure.

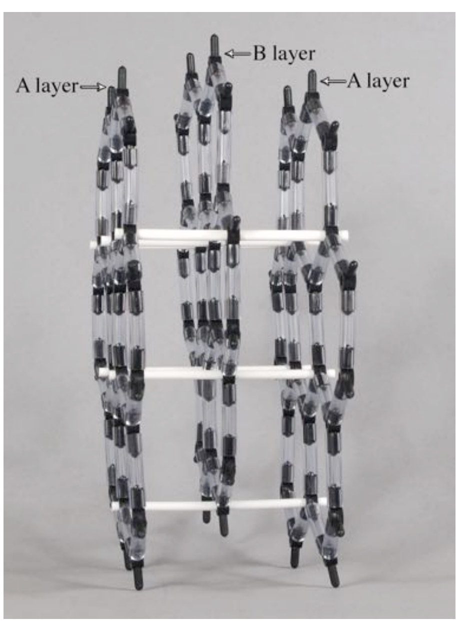

Fig 1 ABA arrangement in graphite (side view).

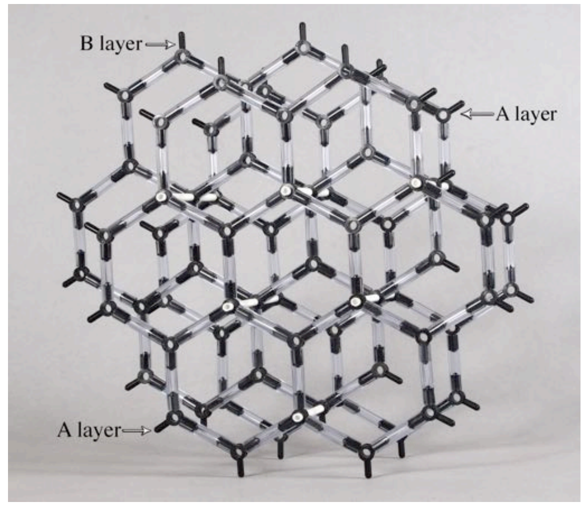

Fig 2 ABA arrangement in graphite (front view).

The graphene layers will also form large arrays in which there are many layers in register, followed by many out of alignment: in other words the layering might look like AAAABBBBAAAA.

The aromatic nature of the rings lends a great deal of stability to graphite. Whereas the bonding within one grapheme sheet is very strong, the bonding between layers is due to weaker van der Waals forces and not able to withstand stress. Therefore, graphene layers are able to slide past one another easily, allowing graphite to act as a lubricant. Presently, scientists are debating the exact nature of the sliding phenomenon.

There are two types of unit cells that graphite can exhibit, the more common rhombohedral (beta form) and the alternative hexagonal (alpha form).

Graphite is soft, marks paper (graphite comes from the Greek word "write"), and is nontoxic. Graphite is a good conductor of heat, and of electricity, so it is used to make electrodes. The "lead" of a pencil is actually graphite mixed with clay. When mixed with various plastics, graphite produces materials of high strength and low weight. It is now found in tennis rackets, fishing poles, golf clubs and even doors on the space shuttle. Synthetic diamonds are made by subjecting graphite to high pressure and temperature.

Scientists are using graphene's high electrical conductivity for several technological applications such as flexible conductors and displays, and computer chips.

Sheets of graphite can fold producing a ball-like structure with rings of six carbons interspersed with rings of five carbons, the Buckyball, or they may roll up to form tubular Buckytubes (nanotubes).

Some other applications of graphite technology include use as moderator in nuclear reactors, making batteries, making steel, use as a vessel to hold materials which will be heated to very high temperatures, contact in motors (brushes), and brake linings.

Graphite Assembly Instructions

1. Construct a hexagon with six of the 3-peg carbon atom centers and six clear tubes. (Fig. 3)

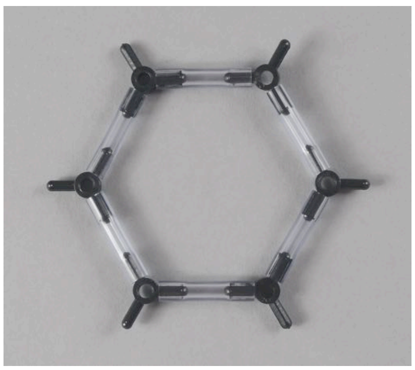

Fig 3 One complete hexagon.

2. Attach four atoms to pegs a and b of the hexagon to form another hexagon. Repeat with atoms c and d and then e and f. Fig. 4 shows the result of adding more atoms.

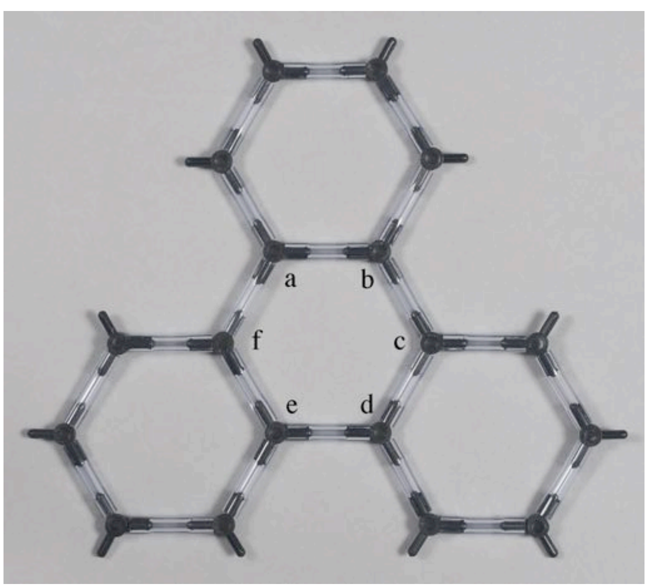

Fig 4 Three new rings.

3. Construct three more hexagons around the middle hexagon with two of the 3-peg carbon atom centers and three clear tubes as shown in Fig 5.

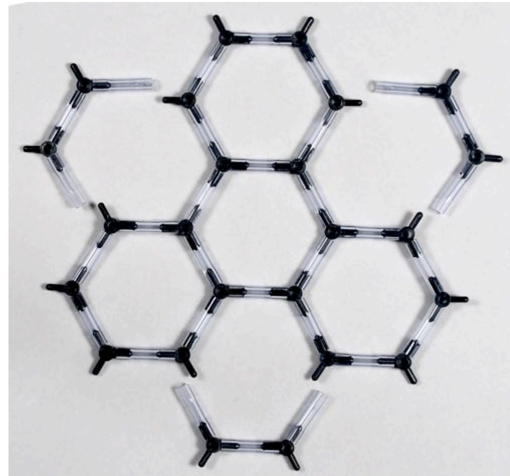

Fig 5 Enlarging the layer with three more rings.

Your final graphene layer should look like Fig 6.

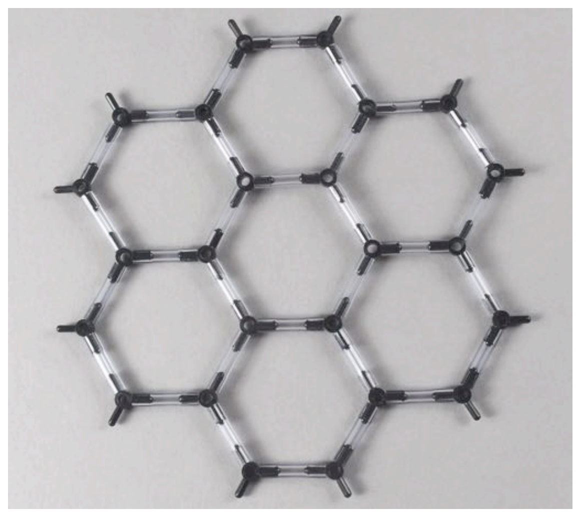

Fig 6 The finished graphene layer.

4. Repeat steps 1-3 two more times so that you have three copies of Figure 6.

5. The three graphene layers may be placed loosely together so that they slide past each other, when demonstrating the slippery nature of graphite.

6. For displaying the model, the three layers may be strung together by running a string through a hole in one atom center of each layer. Alternately, the rigid, white tubing may be used to separate the layers at some fixed distance as in Fig 1 and Fig 2.