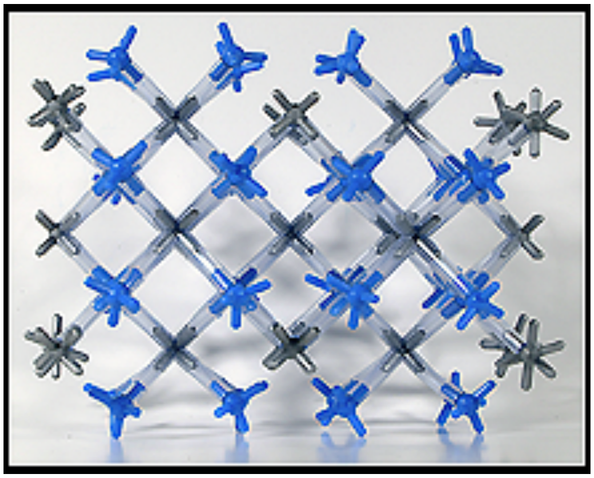
Super Models



Fluorite (Calcium Fluoride)
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.

Kit Contents:
24 silver 8-peg calcium ion centers
49 blue 4-peg fluoride ion centers
130 clear, 1.25" bonds

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General Information

The name fluorite (calcium fluoride) is used by mineralogists, whereas fluorspar is the term applied to this substance by those in industry.

Fluorite is composed of calcium and fluoride ions with a chemical formula of CaF_2. Each calcium ion is surrounded by eight fluoride ions, so the coordination number (CN) for calcium is eight. The CN for fluoride is four.

The term crystal habit means the external shape, crystal structure, and how well developed each factor is. For fluorite, the crystal habit usually is an isometric cube. However, the crystal can break apart easily into a perfect octahedral form. Anyone who is fairly adept at using a small chisel can hit a hand-held fluorite crystal along four planes and produce a well formed octahedral shape. Fluorite can also grow in a pattern known as twinning whereby two crystals share some of the same vertices.

With a Mohs value of four, fluorite is not a particularly hard material.

Crystals of fluorite come in a great variety of colors due to the inclusion of other elements in addition to calcium and fluorine. Some varieties are veritable rainbows of colored bands. Its shades and intensities of color make fluorite desirable as a gemstone and material for working into ornaments for home display. Some examples of fluorite crystals follow in Fig.1.

Fig.1 Examples of fluorite colors.

Fluorite has several more optical properties of interest including opalescence, low light dispersion, transparency to ultra violet (UV) and infra red (IR) light, and fluorescence. In Fig. 2 a demonstration of opalescence is pictured. Light passing through the crystal is orange, but the scattered light seen from the side at 90º is blue. This is an example of the Tyndall effect.

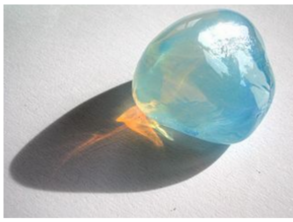

Fig. 2 Fluorite showing opalescence.

Because fluorite causes little chromatic abberation due to its low light dispersion, lenses are often made of the material. Many camera manufacturers grow pure fluorite crystals for manufacturing their lenses.

In scientific optical instruments when UV or IR light must not be blocked, lenses and viewing windows made of fluorite are used.

Because early experiments with fluorescence were carried out on fluorite, the phenomenon carries the mineral's name. Fluorescence occurs when a material is subjected to electromagnetic radiation, or in the case of a type of fluorite called chlorophane when heat is applied (this is called thermoluminescence). Fig. 3 shows an example of the fluorescence of fluorite.

Fig. 3 Fluorite fluorescence.

Industrially, fluorite is used to make hydrofluoric acid, fluorine gas (named after the mineral), enamels, steel and aluminum production, Teflon, and fluoride toothpaste.

Fluorite Assembly Instructions

1. Attach a blue fluoride ion to each of four closest pegs of a silver calcium ion with four clear bonds. Make four calcium ions ready for attachment by placing two bonds on the closest pegs of each ion. See Fig. 4.

Fig. 4 Beginning a unit cell of fluorite.

2. Continuing step 1, attach the bonds of the calcium ions to the fluorides. See Fig. 5.

Fig. 5 Attaching four calcium ions.

3. Attach three bonds to each of four fluorides. Use the four fluorides to bridge the gaps between the four calciums. Make sure that the unattached bonds on the fluorides touch each other. See Fig. 6.

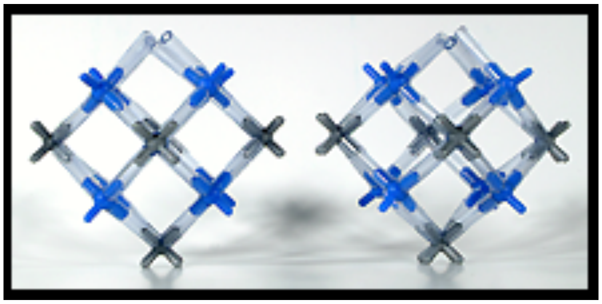

Fig. 6 Duplicate models after bonding four fluorides.

4. Repeat steps 1 through 3, so that you now have two of the same model. See Fig. 6. Each of these models will eventually be seen in the completed crystal as two octahedral holes between calcium layers. Each calcium ion will be located on the face of a cube.

5. Using a single calcium ion as a bridge, attach the duplicated models to each other. See Fig. 7.

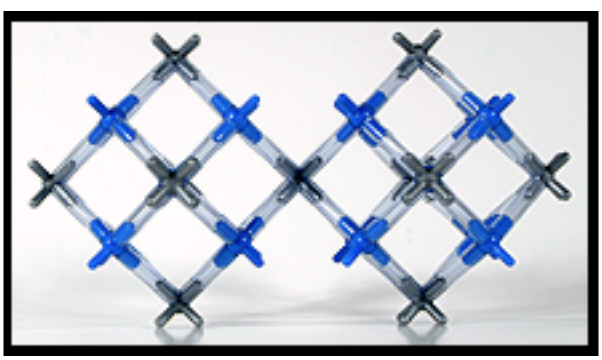

Fig. 7 Calcium ion bridging two identical models.

6. Put two tubes on each of four silver ions, making sure that the pegs of the ions are next to each other. Join the calcium ions to the four blue pegs pointing in toward the center of the model. See Fig. 8.

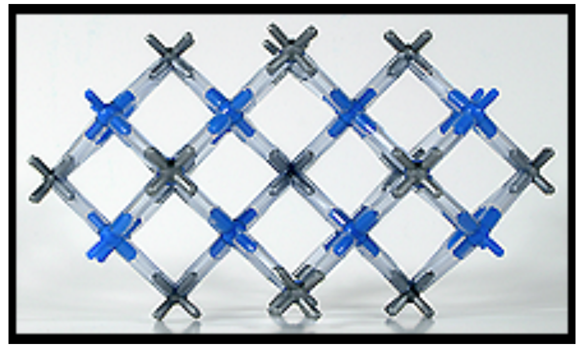

Fig. 8 Bonding four calcium ions.

7. Place a single bond on each of eight calcium ions. The bond each calcium to a blue peg which does not have a bond to it already. See Fig. 9.

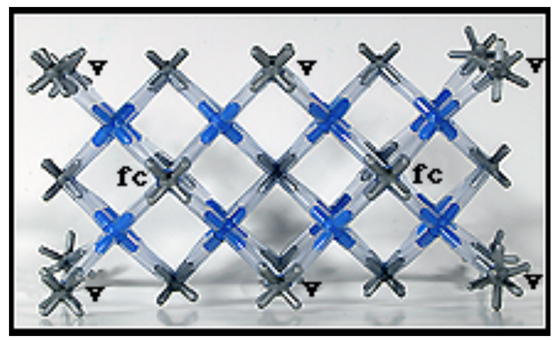

Fig. 9 Completing two adjoining face centered unit cells. v=vertex ion; fc=face centered ion.

8. Put four tubes on each of the eight face centered (fc) calcium ions. Make sure not to put the tubes on the face centered ions at the ends of the crystal. See Fig. 10.

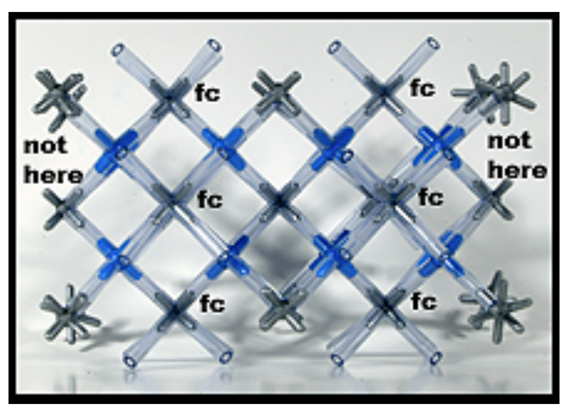

Fig. 10 Placing four bonds on each face centered calcium ion (except at the ends of the crystal).

9. Put a fluoride ion on each tube with a free end. See Fig. 11.

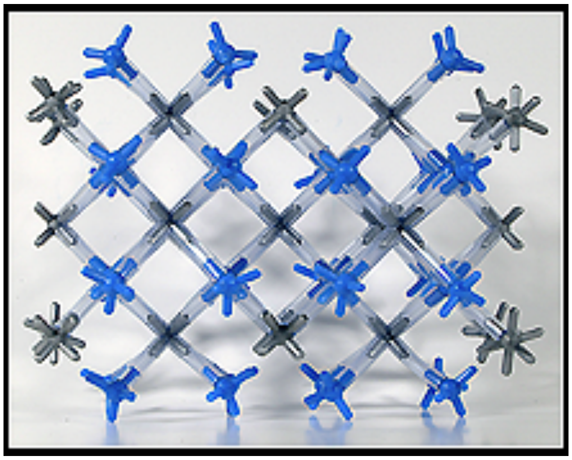

Fig. 11 Placing a fluoride on each free bond.

10. To complete the crystal model, bond each fluoride to a calcium ion closest to it. Make sure that the bond is not distorted (bent). See Fig. 12.

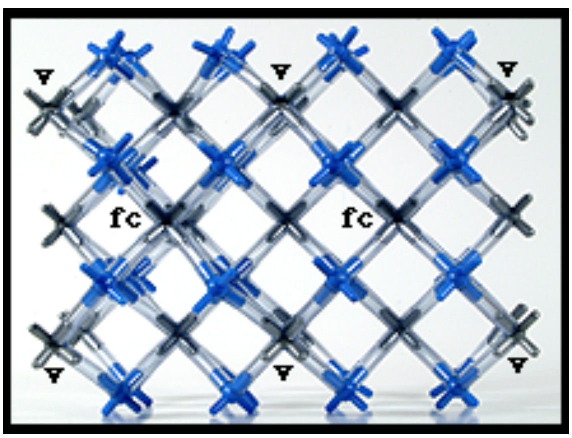

Fig. 12 Completed crystal model with two side-by-side unit cells, The labels indicate calcium ions in the same plane. v=vertex ion; fc=face centered ion.

11. If the fully constructed model is oriented as seen in Fig. 13, you can observe 5 layers of calcium ions and eight layers of fluoride ions. The cations are arranged in an A, B, C pattern of layers. The anions fill the tetrahedral holes above (T_+) and below (T_-) each calcium layer. The tetrahedral shape of a hole is indicated by the tetrahedral shape of the fluoride ion.

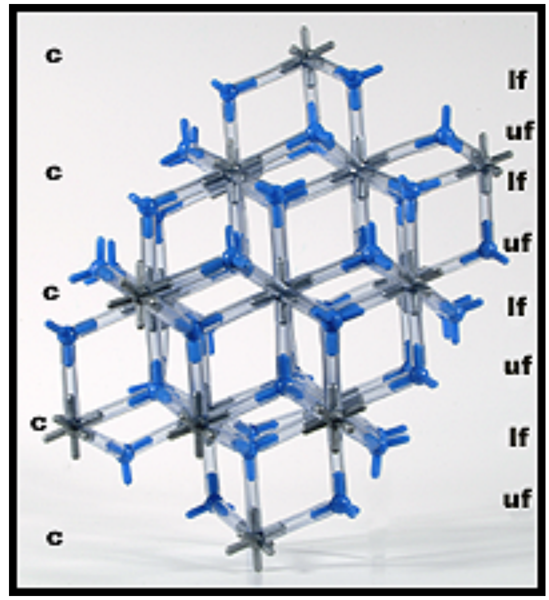

Fig. 13 Orientation of the model showing cation and anion layers. c=calcium layer; uf=upper fluoride layer (T_+); lf=lower fluoride layer (T_-).