Models to Illustrate Ionic and Metallic Solids

Covalent, Ionic and Metallic Bonding

Introduction

Magnetic models demonstrate the arrangement of ions or atoms in crystalline substances and why they have different properties.

Concepts

- Solids and liquids
- Ionic solid
- Chemical bonding
- Metal structure

Materials

Lucite® plastic/Plexiglass®, 3″ × 5″, 9

Magnets, cylindrical, solid, medium size, 74

Hot glue gun and glue

Safety Precautions

Although the materials in this demonstration are nonhazardous, please observe all laboratory safety guidelines.

Preparation

1. Make the first ionic model by gluing 12 magnets in 3 rows onto a piece of Lucite plastic, alternating the polar orientation of the magnets. Repeat on a second piece of Lucite plastic, taking care to alternate the polar orientation of the magnets in opposition to the first piece (see Figure 1).
2. Make a second ionic model by gluing 13 magnets in a different pattern (ex: alternate a column of three with a column of two) onto a piece of Lucite plastic, alternating the polar orientation of the magnets. Repeat on a second piece of Lucite plastic, taking care to alternate the polar orientation of the magnets in opposition to the first piece (see Figure 1).

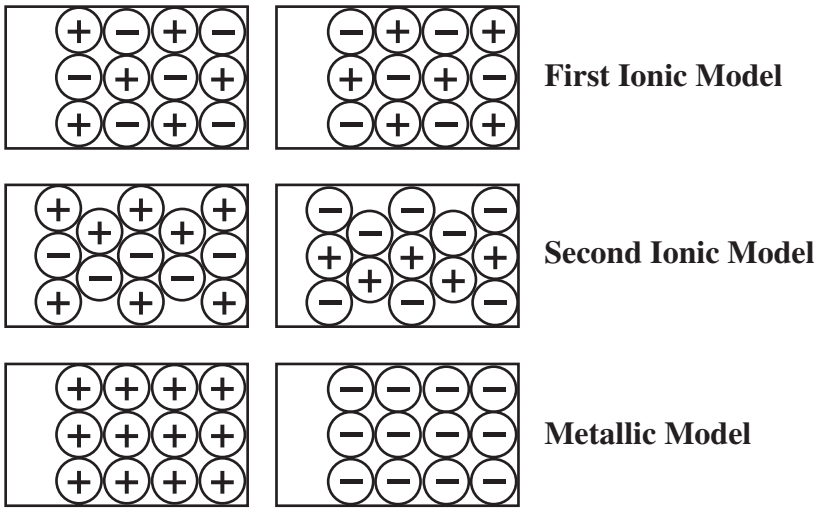

Figure 1.

3. Make the metallic model by gluing 12 magnets in 3 rows onto a piece of Lucite plastic, with the poles all pointed in the same direction. Repeat on a second piece of Lucite plastic and orient the poles so they are pointed the opposite direction of the first piece (see Figure 1).
4. Place a third piece of Lucite in between the two panels of each model.

Procedure

1. Take the first ionic model and slide the top layer. Show how the magnets do not move smoothly, but instead, they jump.
2. Take the second ionic model and slide the top layer. Show how the magnets still jump, even though the packing pattern

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is different.

3. Take the metallic model and slide the top layer. Show how the magnets may move a little, but do not jump like in the ionic models.

Disposal

All materials can be saved to use again.

Tips

- A hot glue gun is used because it is more permanent than other glues. This ensures that the magnets will not move over time.
- In the ionic model, you may wish to paint the magnets to distinguish their polar orientations.
- These models may be passed around to your students so they can try it themselves and feel the difference.

Discussion

A striking consequence of the hardness and brittleness in forces between metallic and ionic crystals is their differences in brittleness. These differences can be simulated very nicely by the use of cylindrical magnets. As shown in Figure 2, magnets were cemented in rows to Lucite plastic. In the metallic model, the poles all pointed in the same direction (N upward on one end, S upward on the other). In the ionic model, the polar orientation was alternated and those magnets having one of the orientations (N or S) were painted to distinguish them. A lateral deformation of one magnet diameter, accomplished by pulling on the plastic panels, shows the difference between the two models. In the metallic model, another stable configuration arises, so the two sets of magnets remain tightly held together. A similar deformation of one magnet diameter in the ionic model causes the two halves to fly apart with considerable vigor, since magnets of identical polarity become aligned. Thus, the hardness and brittleness of ionic crystals is due to the strong attraction of adjacent oppositely charged ions. When a stress is applied to an ionic crystal, the alignment of positive and negative ions may be disturbed enough that ions of like charge are brought next to each other. The resultant repulsion causes the crystal to shatter.

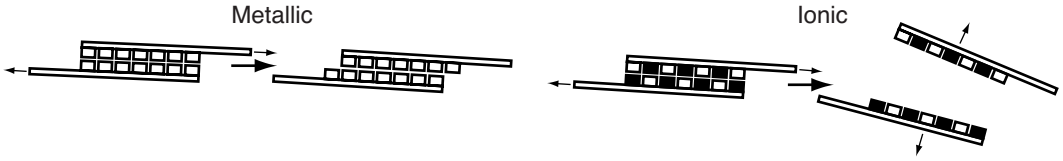

Figure 2.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, motions and forces

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Models to Illustrate Ionic and Metallic Solids* activity, presented by Jesse Bernstein, is available in *Covalent, Ionic and Metallic Bonding* and in *Structures of Solids*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Models to Illustrate Ionic and Metallic Solids* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP4655	Ceramic Disc Magnets, Pkg/6

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.