Electronegativity

A Simple Demonstration Device

Introduction

Help students visualize the abstract concept of electronegativity and its significance in polar covalent and nonpolar covalent bonding with this inexpensive and easy-to-make demonstration device.

Concepts

- Electronegativity
- Covalent bonding

Materials

Knife

Paper clips, large (5-cm length), 4

Rubber bands of equal length but different elasticities (thicknesses), 2

Rubber bands of equal length and of the same elasticities (thicknesses), 2

Styrofoam® balls (1.5″ or 3.8-cm diameter), 4

Safety Precautions

Care should be taken to avoid possible injury due to "accidental" misuse of rubber bands.

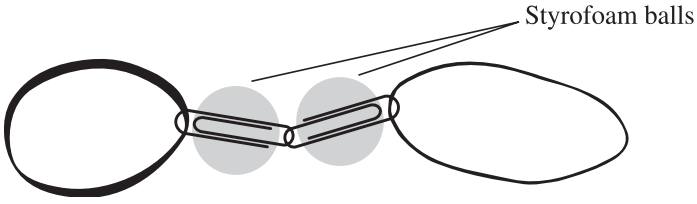

Figure 1: Polar Covalent Bonding Device

Procedure

Part 1. Assembly of Polar Covalent Bonds

1. Link the two paper clips together in an end-to-end fashion to make a "chain" as shown in Figure 1.
2. Loop one strong (thick) rubber band through the outer end of one of the paper clips.
3. Loop one weak (thin) rubber band through the outer end of the other paper clip. The two rubber bands should now be on opposite ends of the paper clip "chain."
4. Use a knife to carefully make a slit halfway through each of two Styrofoam balls (1.5″-diameter). Slice as if you were going to cut the ball in half, but stop at the center of the ball. Then slide these "electron" balls over the paper clips as shown in Figure 1.
5. Once constructed, simply grasp each rubber band between the thumb and index finger of each hand and slowly pull apart. Observe that the two styrofoam balls (i.e., shared electrons) are much closer spatially to the hand holding the thicker rubber band.

Part 2. Assembly of Nonpolar Covalent Bonds

The nonpolar covalent bonding model is almost identical to the polar covalent model with the exception being the choice of rubber bands. The nonpolar covalent model requires that both rubber bands be of the same elasticity. The final result of stretching this model is that the two electrons remain equidistant from both atoms. This clearly illustrates that the two atoms are equally sharing the two bonding electrons.

Disposal

All materials can be saved and reused.

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Discussion

Many chemistry students experience difficulty in grasping the abstract concept of electronegativity and its significance in discussions involving polar covalent and nonpolar covalent bonding. The popular use of Linus Pauling's electronegativity series in many secondary and college general chemistry textbooks allows students to label chemical bonds as nonpolar covalent, polar covalent, or ionic based upon the absolute difference in the two atoms' assigned electronegativity values. While this approach is successful in a quantitative manner, many students still struggle with understanding the concept of electronegativity.

The effectiveness of concrete models during the initial stages of instruction is well known by teachers at all levels. In an effort to help students "see" the concept of electronegativity, a simple, inexpensive model has been created—one that will provide students with a visual depiction of electronegativity.

While introducing the concept of electronegativity to students, it is common to generally describe covalent bonding as a "tug-of-war" for electrons. Continuing with this analogy, this demonstration can be set up by saying that each hand represents an atom, and that each atom pulls on the shared pair of electrons. The students can then be asked to predict which atom will possess the slight positive or slight negative charge. Students often forget that electrons have a negative charge, making the assignment of partial charges slightly confusing.

Variation

The two rubber bands of the models can be looped over two anchored ring stands as one variation of this demonstration as shown in Figure 2. The ring stands must be anchored to the benchtop to keep the rubber bands taut and to prevent the stands from tipping over. Stacking textbooks on the base may help anchor the ring stands. Using the ring stands allows teachers to keep their hands free during the discussion without having to remove the model from the students' view. If desired, elemental symbols can be drawn on construction paper and taped to the ring stands.

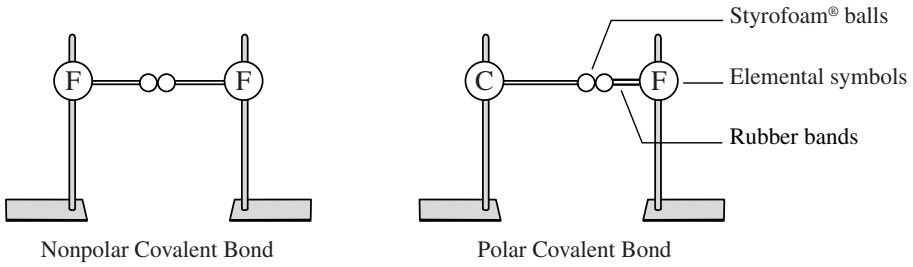

Figure 2: Comparison of Nonpolar and Polar Covalent Bonds

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 5–8
Content Standard B: Physical Science, understanding of motions and forces
Content Standards: Grades 9–12
Content Standard B: Physical Science, motions and forces

Acknowledgments

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References

Bracken, Jeffrey D. *Chem 13 News*, March, 1999, p. 7.

Sivan, Yehosha. *School Science Review*, June, 1992, **73** (265), p. 103.

Chemical Bonding, *Flinn ChemTopic™ Labs*, Volume 5, Cesa, I., Ed.; Flinn Scientific: Batavia, IL, 2004.

Materials for *Electronegativity—A Simple Demonstration Device* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP2280	Styrofoam® Balls, 1.59-diameter
AP6595	Flinn ChemTopic™ Labs, Chemical Bonding, Volume 5

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