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The Disappearing Aluminum Can

An Oxidation–Reduction Activity

Introduction

Many beverage cans are made from aluminum, a malleable, reactive metal. Even when great force is applied to a can, causing the body to collapse, the ends maintain their original shape. Aluminum cans are also able to withstand the acidity and carbonation of many types of beverages contained inside. Are other components besides aluminum present in an "aluminum" beverage can? This demonstration investigates the composition of these familiar cans.

Chemical Concepts

- Metal alloys
- Inert compounds
- Oxidation–reduction

Materials

Sodium hydroxide, NaOH, 2 M, ≈ 250 mL
Aluminum beverage can, full (unopened)
Beaker, 500- or 600-mL
Beaker, 1-L (optional)
Electric sander, or sandpaper
Pencil or stirring rod

Safety Precautions

Sodium hydroxide solution is a very corrosive liquid and is especially dangerous to skin and eyes. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

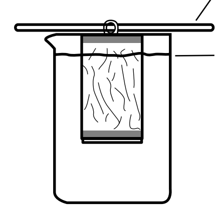

Figure 1.

1. Using an electric sander or sandpaper, buff the paint off of a full can of soda. This is much easier to do when the can is full because the can will be more rigid than when it is empty. *Note:* It is not necessary to remove all of the paint, but try to remove the majority of the paint.
2. Open the can and pour out the contents of the can. Rinse the can thoroughly with water.
3. Fill the can with water.
4. Place a pencil or stirring rod through the tab used for opening the can.
5. Rest the pencil or stirring rod on the rim of a 600-mL beaker so that the can hangs down into the beaker. Working in a fume hood or a well-ventilated lab only, pour 250 mL of 2 M sodium hydroxide down the sides of the can into the beaker. (See Figure 1.) *Note:* If a 500-mL beaker is used, the can will sit on the bottom of the beaker. Although the can will not "hang," the stirring rod should still be kept in place for easy removal of the can from the beaker.
6. The sodium hydroxide solution will bubble as it reacts with the aluminum.
7. Leave the can in the solution for approximately 1–2 hours, checking every 15 minutes or so to see if the shell has become exposed.
8. When the metal rims at the top and bottom of the can are held together by only a thin plastic shell, remove the can from the sodium hydroxide solution and *carefully* rinse (the plastic shell is very brittle) the inside and outside of the can with water.
9. The can may be displayed in a 1-L beaker as shown in Figure 1 (without the sodium hydroxide solution).

Disposal

The waste solutions may be disposed of according to Flinn Suggested Disposal Method #10. Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste.

Tips

- Leaving the can submerged in the sodium hydroxide solution after the shell has been exposed will weaken the plastic, and eventually the plastic will be eaten away completely if the can remains soaking for extended periods of time.
- The can may be left full for this demonstration. In this case, skip steps 2 and 3 of the procedure. Bend the tab by turning it 180° so it is positioned over the can mouth, pull the tab up and bend it backwards until it is bent far enough to put a stirring rod through the hole. *Note:* The weight of the soda in the can may cause pinholes in the plastic, resulting in leakage. Place in a fume hood or behind a safety shield while soaking the full can in the sodium hydroxide solution in case the shell punctures and sprays. Do not use a can that has been shaken, and it is a good idea to tap the top of the can to settle the carbonation before use. Display the can in a beaker (see Figure 1) and use diet pop to make cleanup less sticky.
- Please consult your current *Flinn Scientific Catalog/Reference Manual* for methods of preparing laboratory solutions.

Discussion

Alloys are compounds that contain two or more metals. These materials are created to enhance the usefulness of the primary metal. Properties of alloys are often quite different than the properties of the individual component metals. Aluminum is commonly found in alloy form. Aluminum alloys are categorized by four-digit numbers, where the first number, which ranges from 1–8, gives a general idea of the properties of the alloy.

1xxx — High purity aluminum, at least 99% pure. Primarily used in electrical and chemical applications.
2xxx — Aluminum–copper alloys. Commonly used in aircraft bodies.
3xxx — Aluminum–manganese alloys (up to 1.5% manganese). Good workability; frequently produced as sheet aluminum.
4xxx — Aluminum–silicon alloys. In great demand for architectural applications.
5xxx — Aluminum–magnesium alloys (containing small amounts of manganese). This is a fairly strong alloy and has excellent corrosion resistance.
6xxx — Aluminum–silicon–magnesium alloys. Medium strength; also good at resisting corrosion.
7xxx — Aluminum–zinc–magnesium alloys. Very durable; commonly used in architectural structures.
8xxx — Miscellaneous alloys. Aluminum–lithium alloys are the most common type in this group.

Most aluminum cola cans made in North America contain two different aluminum alloys. The can body is composed of aluminum alloy 3004 or 3104, whereas the ends of the can are aluminum alloy 5182. Aluminum 3004 contains approximately 97.8% aluminum, 1.2% manganese, and 1.0% magnesium (aluminum 3104 is very similar in composition). Aluminum 5182 contains 95.2% aluminum, 4.5% magnesium, and 0.35% manganese. As stated above, alloys in the 5 series are good at resisting corrosion. This explains why the ends of the can remain intact after the sodium hydroxide has eroded away the body of the can. The inside of the can is lined with a spray-on, water-based, inert polymer (i.e., plastic). The plastic is chemically inactive and has a greater resistance than aluminum against both acidic beverages and the basic sodium hydroxide used in this demonstration.

The reaction that occurs between the aluminum can and the sodium hydroxide is

$$2Al(s) + 2OH^-(aq) + 6H_2O(l) \rightarrow 2[Al(OH)_4]^-(aq) + 3H_2(g)$$

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Acknowledgments

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Materials for *The Disappearing Aluminum Can* are available from Flinn Scientific, Inc.

Catalog No.	Description
S0447	Sodium Hydroxide Solution, 3 M, 500 mL
S0165	Sandpaper, pkg./4, 9″ × 11″ sheets

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