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Making Glass

Industrial Chemistry

Introduction

Use different transition metal salts to make colored glass in an entertaining activity the combines art and chemistry!

Concepts

- Transition metal colors
- Cross-curriculum

Materials

Boric acid, H_3BO_3, 3 g
Lead(II) oxide, PbO, 5 g
Zinc oxide, ZnO, 0.5 g
Beaker burner
Clay triangle
Ceramic fiber square, 12″ × 12″
Crucible
Crucible tongs
Ring stand with small ring
Spatula
Stirring rod, glass
Wire gauze with ceramic center

Optional Transition Metal Colorants

Chromium salt, less than 0.5 g
Cobalt salt, less than 0.5 g
Copper(II) oxide, CuO, less than 0.5 g (blue-green, turquoise)
Iron salt, less than 0.5 g
Manganese(II) sulfate, $MnSO_4$, less than 0.5 g (rose)

Safety Precautions

Zinc oxide fumes could be severely toxic and may react vigorously with some forms of rubber at elevated temperatures. Lead oxide is a possible carcinogen and moderately toxic by ingestion and inhalation. Boric acid is slightly toxic by ingestion, and is an irritant to skin. This demonstration includes heating to high temperatures. Be careful to use all proper personal protective equipment to avoid any heat transfer to the skin. Avoid contact of all chemicals with eyes and skin. Follow all laboratory safety guidelines. 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. Remember to wash hands thoroughly with soap and water before leaving the laboratory. (For transition metals colorants please consult all safety guidelines and read all Material Safety Data Sheets for additional safety, handling, and disposal information before working with or ordering any chemicals. For example, Manganese(II) sulfate, is a body tissue irritant, with a licensed hazardous waste disposal requirement for unused material.)

Procedure

1. Set up a ring stand with a small ring and clay triangle on a heat resistant pad/ceramic square. Check the fit of the crucible and clay triangle and adjust the height as needed in relation to the beaker burner.
2. Mass 5.0 g of lead(II) oxide, 3.0 g of boric acid and 0.5 g of zinc oxide and place these three powders into the crucible, taking great care to mix the powders thoroughly.
3. Place the lid on the crucible, if desired, and heat the crucible until red hot. The mixture should become a flowing liquid.

4. If a plain sample is desired, using the crucible tongs, remove the very hot crucible from the heat and carefully pour the molten glass onto the ceramic center of the wire gauze in small drops.
5. If colored glass is the desired result, omit step 4 altogether or only pour a drop or two for comparison and replace the crucible back on the heat.
   a. Add a very small amount of a transition metal salt for color. If too much transition metal compound is added the glass will be too dark.
   b. Mix thoroughly and heat until completely melted.
   c. Use the crucible tongs to pick up the very hot crucible and pour the molten glass onto the ceramic center of the wire gauze in small drops.
6. The droplets of glass will be very hot and will need time to cool before moving or handling.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines on specific procedures governing the disposal of laboratory waste. The glass produced can be stored, displayed or disposed of in the trash.

Tips

- When using transition metal oxides use very small quantities so that the glass does not become too dark.
- This is not the type of glass that is normally used for commercial purposes but this glass can be made at lower temperatures, which is more favorable in the classroom.
- Do not use Chromium(VI) oxide, which is a known carcinogen. If using chromium as a colorant, Chromium(III) oxide is less hazardous.
- Nickel compounds are known carcinogens through the inhalation of dust. Therefore, it is not recommended that any nickel compounds be used to color glass.
- Glass has a rich history and many student projects can be incorporated into the curriculum. Sample topics would include: its origination, chemical composition, how chemical composition is varied for specific uses, industrial production and design, artistic uses, glass blowing, etc.

Discussion

Glass is a common everyday substance. The glass made in this procedure is not normally made commercially but it is useful as a classroom activity because the temperatures required to produce the glass are lower than that of traditional commercial glass. Glass properties can be varied by using different amounts of components or materials. For example, adding boric oxide to the glass composition tends to lower the thermal expansion of the glass making it more resistant to breakage, especially if formed commercially. There are two main types of glass used in the laboratory, soft-glass and borosilicate glass. Soft glass (also known as soda-lime or non-borosilicate glass) is composed of 75% silica (SiO_2), 20% soda ash (Na_2CO_3), and 5% lime (CaO). Borosilicate glass is a strong, heat-resistant, soda-lime glass that contains a minimum of 5% boric oxide. It has a low coefficient of expansion and very high resistance to chemical attack. Borosilicate glass can withstand continuous use at temperatures up to 482 °C. Common trade names, for borosilicate glass include Pyrex® and Kimax®.

Connecting to the National Standards

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

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

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Making Glass* activity, presented by John Mauch, is available in *Industrial Chemistry* and in *Periodic Table Demonstrations and Activities,* part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Making Glass* are available from Flinn Scientific, Inc.

Catalog No.	Description
B0137	Boric Acid, Reagent, 100 g
L0082	Lead Oxide, Mono, 100 g
Z0013	Zinc Oxide, 500 g
AP1253	Crucible, Porcelain, Wide-Form, Coors
AP8247	Crucible Cover, Porcelain, Coors
AP8330	Triangle, Pipe Stem
AP8266	Crucible Tongs
AP1189	Wire Gauge Squares, Steel with Ceramic Centers
AP4588	Ceramic Fiber Square

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