Salt with a Sparkle

Nuclear Chemistry

Introduction

When ordinary table salt is irradiated, it turns brown due to "color centers" (defects) in the excited-state crystal structure. When the irradiated salt is heated on a hot plate, it gives off flashes of light and turns white as the excited-state crystal returns to the ground state. The thermal fluorescence of irradiated table salt is used to illustrate crystal defects.

Concepts

- Irradiation
- Excited state
- Crystal structure
- Fluorescence

Materials

Hot plate

Irradiated table salt

Safety Precautions

Irradiated salt is not radioactive nor is it more hazardous than normal table salt. However, it should be treated as a laboratory chemical and not consumed. A "hot" hot plate looks exactly like a cold hot plate! To avoid burns, place a HOT sign next to the hot plate before the demonstration and also afterwards to warn students and other teachers that the hot plate is indeed hot. Wear chemical splash goggles whenever working with heat, chemicals or glassware in the laboratory. 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.

Procedure

1. Turn on the hot plate to its highest setting beforehand so that it will be hot at the time of the demonstration.
2. Show a sample of the irradiated table salt, which is orange-brown in color.
3. With the room darkened, sprinkle the irradiated salt sample on the hot surface of the hot plate. Have students observe with their sense of sight and sense of hearing. The heated salt sparkles, and a sizzling sound may be detected.
4. Turn on the lights and note the color of the salt sample, which is now white.

Disposal

Please consult your current Flinn Scientific Catalog/Reference Manual for general guidelines on specific procedures governing the disposal of laboratory waste. The salt may be flushed down the drain with water according to Flinn Suggested Disposal Method #26b.

Tips

- The concepts involved in this demonstration can also be related to devices used to detect radiation exposure in radiation workers. Thermoluminescent dosimeters (TCD) contain LiF (rather than NaCl), which "stores energy" when exposed to ionizing radiation. The LiF is then heated to release its stored energy and the amount of energy that is released is measured with a light-sensitive instrument (e.g., a photomultiplier tube). The amount of light released corresponds to the energy that was deposited in the LiF salt as the ionizing radiation passed through the material.
- The darker the room, the easier it is to observe the sparkling salt.

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Discussion

When sodium chloride is irradiated with high doses of gamma radiation, defects in the crystal structure are formed. These defects cause the salt to appear orange-brown in color. The radiation also provides the necessary energy to excite electrons within the crystal structure. These electrons are trapped in the crystal defects. The irradiated salt crystals exist in a stable, albeit excited state, and will remain in this "potential energy well" until additional energy is added.

When energy is added to the stable excited state in the form of heat, the electrons obtain sufficient energy to get out of the energy well and return to the ground state. When the electrons return to their ground state, energy is emitted in the form of light. This is thermal fluorescence. The heating also decreases the rigidity of the crystal lattice, allowing the salt crystals to revert to their original, defect-free state, which is white in color. The salt is not radioactive. A discussion of irradiated foods can ensue.

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
Constancy, change, and measurement
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, conservation of energy and increase in disorder, interactions of energy and matter
Content Standard F: Science in Personal and Social Perspectives, natural and human-induced hazards, science and technology in local, national, and global challenges

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Salt with a Sparkle* activity, presented by Kathleen Dombrink, is available in *Nuclear Chemistry*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Salt with a Sparkle* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6613	Irradiated Salt

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