Phosphorescent Paper

Introduction

This glow-in-the-dark paper gives off a bright yellow-green glow upon absorption of light. Simply expose the sheet to the lights in your classroom, then darken the room and observe the brilliant glow!

Concepts

- Phosphorescence
- Absorption/emission

Materials

Phosphorescent paper

Light source—classroom lights work well

Safety Precautions

Follow normal laboratory or classroom procedures.

Procedure

1. Illuminate the phosphorescent paper with regular classroom lights for 30 seconds.
2. Completely darken the room. The sheet will glow in the dark!

Extensions

- When the room is lighted, have a student place her hand on the phosphorescent paper so that no light shines on the portion of the sheet covered by the hand. Have her hold her hand on the sheet for at least 30 seconds. Then, completely darken the room and have the student remove her hand. Now the sheet will glow everywhere but where the student's hand was placed. Try the same procedure, but use pieces of paper cut into letters or shapes to spell a word or trace a figure.
- Surprise your students! Print a class activity on the phosphorescent paper. Pass out the activity to your students, but tell them not to begin until you have turned out the lights. Completely darken the room and watch your students' surprised faces as the activity is illuminated on the glowing paper.
- Design an image on your computer. Print the image on a piece of the phosphorescent paper using an ink-jet printer. Illuminate the sheet of paper under the regular classroom lights for 30 seconds, then completely darken the room. The paper will glow everywhere except where it has been printed on, creating a silhouette of the printed image. A silhouette effect can also be created by writing on the paper with a black marker.
- The maximum wavelength of light needed to make the phosphorescent paper glow can be measured in a spectrophotometer. First, cut a piece of the paper narrow enough to slide down inside a spectrophotometer cuvet. Set the wavelength on the spectrophotometer. Set 0% T with the sample compartment empty. Use an empty cuvet as the blank to set 100% T. Place the phosphorescent paper in the cuvet. Then place the cuvet in the spectrophotometer and measure the absorbance of the strip. Make sure the coated side of the strip is facing the direction from which light comes in your spectrophotometer. Repeat, varying the wavelength for each measurement. For wavelengths of about 480 nm and lower, a small glowing spot can be seen on the phosphorescent strip. At higher wavelengths, no glowing is observed. This experiment is best performed in the dark so that the glowing spot is easily seen.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The phosphorescent paper can be stored and reused year after year. However, if desired, dispose of the sheet in the trash according to Flinn Suggested Disposal Method #26a.

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Connecting to the National Standards

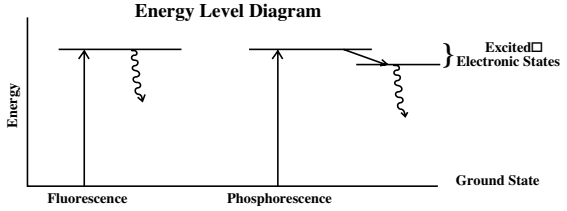
This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, interactions of energy and matter

Tips

- Store the phosphorescent paper in a dark envelope or some other container that protects it from light. This will lengthen the life of the phosphorescent material in the sheet.
- The phosphorescent paper is designed to be used with ink-jet printers only, not laser or dot-matrix printers.

Discussion



Luminescence is the emission of radiation (light) by a substance as a result of absorption of energy from photons, charged particles, or chemical change. It is a general term that includes phosphorescence, fluorescence, and chemiluminescence, to name just a few special types. *Phosphorescence* is different from the other types of luminescence in that light continues to be emitted even after the exciting source has been removed. This is sometimes referred to as the "afterglow." In this demonstration, the exciting source is the lights in your classroom. The phosphorescent paper glows even after the lights have been turned off (removal of the exciting source), so it can be classified as a phosphorescent material.

Why does a phosphorescent material continue to glow even after the exciting source has been removed? This can be explained by looking at an energy level diagram for the phosphorescent material. In both phosphorescence and fluorescence, a light source is shined on the material, and a photon is absorbed. The energy from the photon is transferred to an electron that makes a transition to an excited electronic state. From this excited electronic state, the electron naturally wants to relax back down to its ground state. When the electron relaxes, it does not necessarily return to the ground state in a single step. The relaxation pathway varies, and is different depending on whether the material is undergoing fluorescence or phosphorescence.

In fluorescence, the electron relaxes down to a lower energy state and emits a photon in the process. If this photon has a wavelength in the visible portion of the electromagnetic spectrum, we observe a colorful, glowing effect. This process is practically instantaneous so the fluorescence is observed as soon as the exciting source is present, and it disappears as soon as the exciting source is removed.

In phosphorescence, the excited electron first makes a slow transition to another excited state very close in energy to the initial excited state. From this second excited state, the electron then relaxes down to a state lower in energy, emitting a photon in the process. The characteristic afterglow of phosphorescence is due to the delayed emission that occurs because the transition between the first two excited states is slow.

Materials for *Phosphorescent Paper and other phosphorescence demonstrations* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP5887	Phosphorescent Paper, 12 sheets/pkg
AP4794	Phosphorescent Vinyl Sheet, 12″ × 12″
P0272	Phosphorescent Flash Paint
AP8685	Flinn Scientific Spectrophotometer
AP4576	Energy in Photons Kit

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