PHOTO LUMINESCENT PIGMENT

Words written on a phosphorescent screen using an UV LED microlight

Phosphorescent materials

Photo luminescence is a process in which a chemical compound absorbs a photon (electromagnetic radiation), moves an outer orbital electron to a higher energy state and then radiates a photon out as the electron returns to its ground state. The period between absorption and emission is typically extremely short, in the order of 10 nanoseconds (fluorescence). Under special circumstances, however, this period can be extended into minutes or hours (phosphorescence).

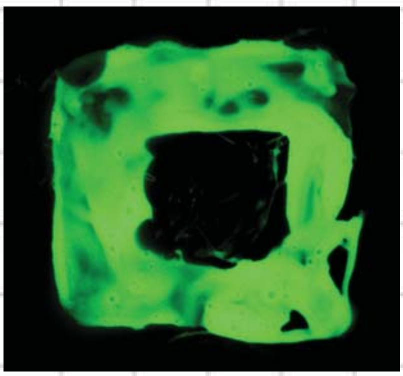
Phosphorescent materials are activated by exposure to UV light that is found in varying degrees of intensity in light sources such as sunlight and incandescent lighting. These materials exhibit the delayed emission of light producing the typical "after-glow" effect. The light emitted is within the visible spectrum and harmless to the human eye.

For many years zinc sulphide was the only phosphorescent material in use. Its major drawback being a much shorter after-glow period and deterioration by UV radiation. Strontium oxide aluminate, another effective photo luminescent compound, produces bright after-glow effects but is very expensive.

The photoluminescent pigment supplied by Prof Bunsen Science is designed for a wide range of applications and slower rates of after-glow decay. Their intended use is for long after-glow applications in coatings and plastics (12 hrs plus). Chemically, these newly developed compounds are crystals of the aluminate-silicate family: halogenated alkaline-earth and aluminium oxide based crystals doped with rare-earth elements.

Applications are numerous in both the commercial and domestic markets. Where ever illumination without a continuous external electrical power source is desired, applications are found. To name a few: safety and evacuation systems, luminous toilet seats, light switch covers, paints, textile dying, step and floor products for trains, trams, buses and airport landing strip markers, etc.

Preparing a photo luminescent screen



Required

Photo luminescent pigment
Sturdy cardboard sheet or other surface to be painted
Wood glue (PVA or other)
Lab scale up to ±0.1 g
Plastic cup or other container for mixing
Wooden stick
Squeegee or wooden stick ("tongue depressor stick")

Safety

The aluminate-silicate pigment is classified a non-hazardous chemical but contains tiny particles (88% are smaller than 5 microns) and may cause mechanical eye irritation. Avoid eye exposure or the breathing of the dust. Use exhaust ventilation and wear proper protection when handling. See the MSDS on our website before use.

PROCEDURE

The process entails the preparation of a photo luminescent paint with the following composition:

PVA Glue	75%
Luminescent pigment	25%

Calculate the correct amount to be mixed: 15g photo luminescent paint provides an even, thick coating for a 100 cm^2 surface area.

1. Do your calculations. Place the cup on the scale and measure the correct amount of pigment.
2. Then squirt the correct amount of PVA glue into the cup.
3. Mix the paint with the stick.



4. Now, evenly spread the paint across the cardboard surface with a squeegee or ruler. A thicker spread will provide a better glow-in-the dark surface.


5. Leave to dry overnight.
6. Store the luminescent screen in a padded envelope to protect it from scratching.

Things to do with the photo luminescent screen

Max Planck determined the relationship between the photon energy of light and its frequency:

$$E = hf \quad \text{and} \quad c = f\lambda$$

where E is the photon energy associated with the light source, h is Planck's constant, f the frequency and λ the wavelength of the light.

This indicates that a UV source at 405 nm will have a higher energy value than red light at 630 nm.

Thus, high-frequency electromagnetic waves have a short wavelength and high energy; low-frequency waves have a long wavelength and low energy.

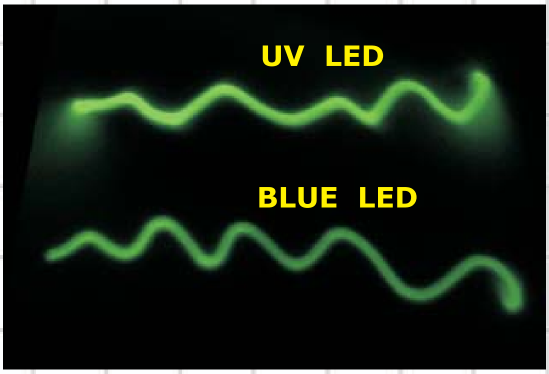
The **photoelectric effect** postulated by Einstein states that electrons can be liberated from a substance exposed to electromagnetic radiation matching the appropriate threshold energy levels. The kinetic energy of the electrons emitted depends on the frequency of the radiation.

Although no free electrons are emitted from our phosphorescent material radiated by light, the material gives a great visual indication of the energy associated with the radiation source. Light sources with higher energy levels will excite the screen visibly longer and with a more intense after-glow than lower energy sources.

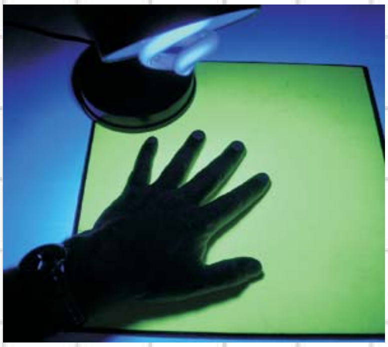
Now, try the following **demonstrations:**

- Dim the lights and expose the photo luminescent screen to equally bright LED micro lights of different colours. First the red, then the green, the blue, the white and lastly the UV.

LED Microlights



- Purchase a black-light bulb (UVA) from an electrical or hardware store. Dim the lights and cover the screen with your hand while exposing the screen for a few seconds to the UV source. Switch off the UV source and remove your hand. Alternatively use the sun, a camera flashlight or a fluorescent tube.



More on **UV radiation**:

When considering the effect of UV radiation on human health and the environment, the range of UV wavelengths is often subdivided into **UVA** (400 - 315 nm), also called long wave or "blacklight"; **UVB** (315 - 280 nm), also called medium wave; and **UVC** (<280 nm), also called short wave or "germicidal".

The Sun emits ultraviolet radiation in the UVA, UVB, and UVC bands, but because of absorption in the atmosphere's ozone layer, 99% of the ultraviolet radiation that reaches the Earth's surface is UVA.

UVA, UVB and UVC can all damage collagen fibers and thereby accelerate ageing of the skin. In general UVA is the least harmful. It penetrates deeply into the human body but does not cause sunburn.

A positive effect of UVB light is that it induces the production of vitamin D in the skin but high intensities of UVB light are hazardous to the eyes, causing the reddening of the skin and can cause skin cancer.

As a defense against UV radiation, the body tans when exposed to moderate levels of radiation by releasing the brown pigment melanin. This helps to block UV penetration and prevent damage to the vulnerable skin tissues