LIGHTING UP PHOSPHORESCENT FILM

Materials:

- Phosphorescent film
- Flashlight
- Transparent films of different colors (For example, red, blue, green)
- A watch to keep track of time.
- Different objects

Instructions:

1. This experiment needs to be performed in a relatively dark room.

2. Note what happens when you place different objects on the phosphorescent film and then expose it and the film to the light from the flashlight.

3. What happens when you bring the flashlight farther away and expose for the same length of time?

4. What happens to the intensity of the phosphorescence as you shine the light in different spots for longer and longer time periods. You could compare 5 s, 10 s, 20 s, 40 s, for example. (If you illuminate a series of spots from highest time to lowest time, then you might be able to compare the set of spots simulataneously.

You can make this a quantitative measurement by using your smart phone and a color meter app. A free one for iphone is *What a Color?* For this app, you need to take a picture of the image and then you can go in and determine the RGC or CMYK designations. If you plot the measurement of the phosphorescence (such as the G or the K values) as a function of the illumination time, what does that curve look like?

5. Place different color filters between the flashlight and the phosphorescent film and compare the brightness of the spots for the white light alone and through the filter. (Also try Roscosun 85N.6, Industrial Vapor, in addition to the color filters)

   For a dramatic comparison, place the filter halfway across the area illuminated by the flashlight. Turn on the flashlight to excite the phosphorescent film, turn off the flashlight, and then quickly remove the color filter. This approach simultaneously illuminates the phosphorescent film with and without the color filter.

   Which colored filters provide the highest phosphorescence? ___________________

   Which colored filters provide lower phosphorescence?

   Write the filters in order of providing the highest phosphorescence to lowest phosphorescence? ________________> ________________ > ________________

   Do any filters provide the same phosphorescence intensity as the white light alone? Which one? _______________________

Use the attached transmission spectra of different colored filters to determine which colors affect and block phosphorescence.

6. Take a look at the Jablonski diagram (next page). It shows some possible energy levels to which electrons in a molecule can be excited to and how that energy can be lost. The farther apart the energy levels for the transition, the larger the energy it takes to do that.

You can't get more energy out than the amount of energy that goes in. If high energy light (like ultraviolet) is absorbed by molecules, their electrons are excited to higher potential energy levels. If low energy light like red light is absorbed, electrons can only be excited to lower potential energy levels.

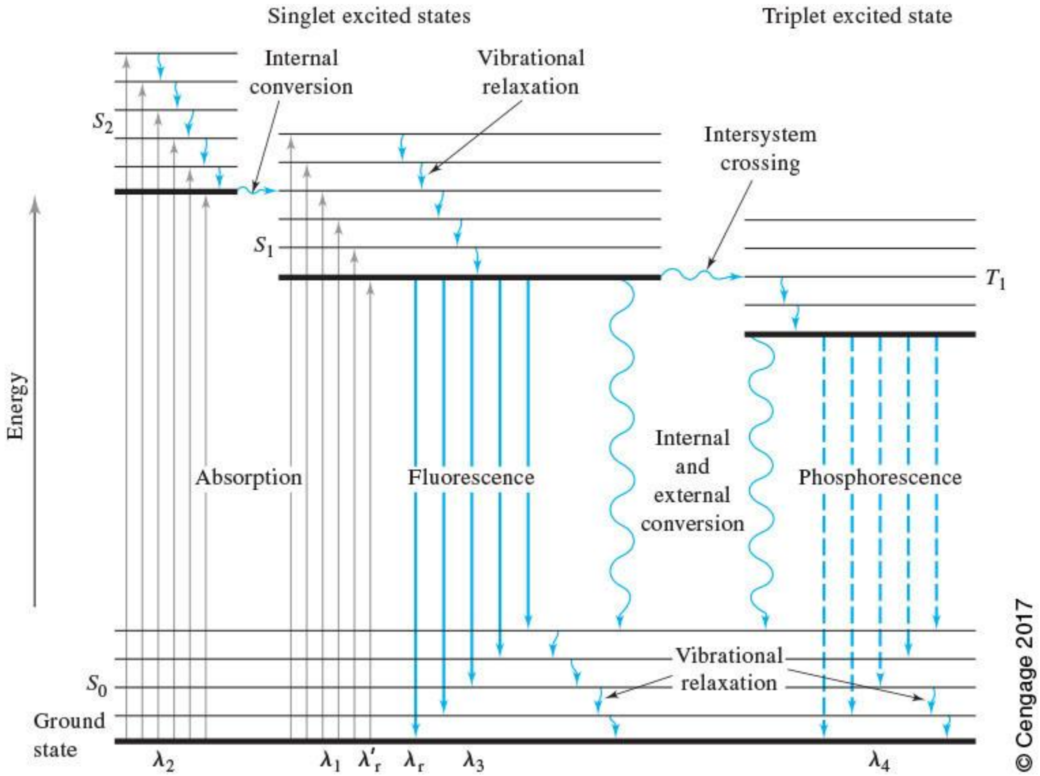
That energy absorbed by the molecule can then be lost in many ways as shown in the diagram. Some are nonradiative pathways like vibrational relaxation and external conversion. Other pathways are radiative, when energy is emitted as light. ***This emitted light must be equal to or lower than the energy of light absorbed.***

One of those radiative pathways is fluorescence. This has a short duration. So, when you turn off the blacklight, the fluorescence disappears.

Another radiative pathway is phosphorescence. An electron's spin flips (during intersystem crossing), and thus stays longer in the excited state before relaxing back to the ground state. This phenomenon allows you to turn off the excitation light and see an object continue to phosphoresce for minutes to hours. It can "glow" in the dark.

7. Explain why there is phosphorescence with some color filters between the exciting light and the object and why there is little to no phosphorescence with other color filters. Use the transmission spectra that accompany the color filters to explain the results.

Theory—The Jablonski Diagram



Douglas A. Skoog, F. James Holler, S. R. Crouch, "Principles of Instrumental Analysis", Seventh Edition, Boston, MA: Cengage Learning, 2018.