NATIONAL PARK SERVICE
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Conserve O Gram

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The Use Of Ultraviolet Induced Visible-Fluorescence In The Examination Of Museum Objects, Part I

A commonly available ultraviolet lamp can be used as a tool to aid in the examination of museum objects. Ultraviolet radiation is invisible to the naked eye. However, when it is emitted from an ultraviolet lamp and directed at the surface of an object, it is often transformed into visible colors. These colors are known as ultraviolet-induced visible fluorescence. In conjunction with other examination techniques, observation of this fluorescence can help collections managers to answer questions regarding the identification of materials and the condition of artifacts. In turn, this information may aid in making decisions regarding issues such as handling, storing, and cataloging of collections. (See *Conserve O Gram* 1/10, The Use of Ultraviolet Induced Visible-Fluorescence in the Examination of Museum Objects, Part II for more information.)

Much effort has been made in recent years to limit the exposure of museum objects to ultraviolet radiation. Over time, ultraviolet from both artificial sources and natural sunlight has a cumulative effect on materials and can cause damage and fading of items such as textiles, paper, and other organic objects. The amount of ultraviolet radiation absorbed by an object during a brief examination using an ultraviolet lamp is very small. If a pertinent question about the object can be answered using ultraviolet-induced visible fluorescence, the use of this technique may be considered acceptable.

The Electromagnetic Radiation Spectrum

Ultraviolet (UV) radiation, along with visible light, infrared, radio waves, x-rays, and the less familiar gamma rays and cosmic rays, is a form of electromagnetic radiation. (See Figure 1.)

All forms of electromagnetic radiation are classified according to wavelength. Wavelengths are measured in nanometers (nm). A nanometer is one billionth of a meter.

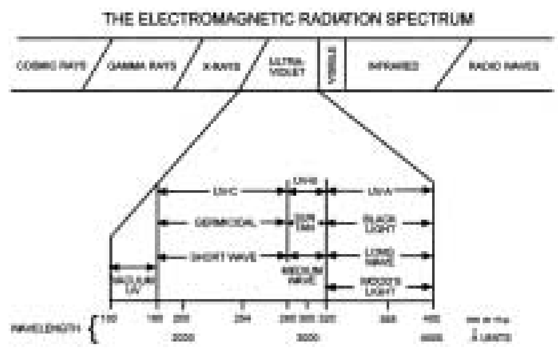

***Figure 1**. The Electromagnetic Radiation Spectrum.*

Visible light is the only portion of the electromagnetic spectrum that can be seen by the human eye. Visible light radiates at wavelengths between 400 and 700 nm. UV radiates at shorter wavelengths, between visible light and X-rays. (See Figure 1.)

The ultraviolet portion of the electromagnetic spectrum can be further broken down into the following regions:

- *UV-A*, commonly known as long-wave UV, near-ultraviolet, black light, or Wood's light (between 320 and 400 nm)
- *UV-B*, also known as medium-wave UV (between 280 and 320 nm)
- *UV-C*, often referred to as short-wave, far-ultraviolet, or germicidal UV (between 180 and 280 nm)

Of these regions, UV-A (long-wave) and UV-C (short-wave) are the most useful in examining museum objects. Commercially made long-wave UV lamps and short-wave UV lamps are readily available from various vendors.

Ultraviolet-Induced Visible Fluorescence

Many natural and synthetic materials transform the ultraviolet radiation that strikes them into longer wavelength visible radiation or visible light. This phenomenon is referred to as ultraviolet-induced visible fluorescence. When UV radiation is absorbed by a reactive material, electrons are pushed temporarily into a higher energy state. The absorbed radiant energy is released as these electrons return to their normal state. Much of this released radiant energy, or fluorescence, has wavelengths in the visible light region and thus can be observed. Whether fluorescence occurs at all, as well as the color, or specific wavelength of the fluorescence, depends on the material under illumination and the wavelength of the UV radiation that is used.

Personal Safety

Long-term exposure to UV radiation can lead to serious and irreversible vision problems, including cataracts, glaucoma, and macular degeneration. It is recommended that protective eyewear be worn at all times when working with a UV lamp. It is especially important when working with lamps emitting UV-C, or short-wave UV, which is most damaging to the eyes. Safety glasses of polycarbonate and other plastics, made specifically to filter UV light, are commonly available. Glasses that fit over prescription lenses can also be purchased.

Examining Art and Artifacts

To view an object with a UV lamp, choose a dark room, such as a storage or photography area. Fluorescence is not very bright, so as much as possible, eliminate sources of stray light through windows and doors. Block-out curtains and shades can be used on windows, and sand snakes can be placed at door thresholds. With overhead lights or a task light turned on, place the object securely on a table or easel. Use weights as necessary to secure the object in place. Plug in the UV lamp (unless it is battery-operated), and take care that the cord is not tangled and that it cannot accidentally knock over the object while it is moved in the dark.

Turn off the room lights and let your eyes adapt to the darkness for a minute or two. Observe the object under UV radiation. Areas that appear totally dark are not fluorescent. Some non-fluorescent surfaces (e.g. metals) may reflect some of the small amount of visible light that is emitted from the UV lamp. Be careful not to confuse this reflection with fluorescence. Turn on a dim task light as necessary for a frame of reference or to take notes.

Never attempt to move or reposition the object, or to clean, test, or otherwise alter an object under UV illumination. These activities should be undertaken only when the room or task lights are turned on. The UV lamp should only be used to examine an object.

Remember, the colors of the observed fluorescence will depend on the material and the wavelength of the UV light that is being used. It is important to use a UV lamp with the appropriate wavelength for the question(s) at hand. For example, many adhesives used in coating and repairing objects fluoresce under long-wave UV and do not fluoresce at all under short-wave UV. Therefore, a long-wave UV lamp should be used to determine if an object, such as a ceramic, has been broken and repaired. On the other hand, many mineral specimens fluoresce characteristic colors under short-wave UV and do not fluoresce under long-wave UV. Therefore, a short-wave UV lamp should be used to aid in classifying and cataloging this type of collection. (See *Conserve O Gram* 1/10, The Use of Ultraviolet Induced Visible-Fluorescence in the Examination of Museum

Objects, Part II, for further information and for guidelines in choosing a UV lamp.)

As with any examination or analytical technique, avoid drawing conclusions about an object based on ultraviolet-induced visible fluorescence alone. Instead, it is best to make observations and to use these in conjunction with other evidence about the object. This caveat is especially true with regard to issues of authenticity.

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The author would also like to thank Spectronics Corporation of Westbury, New York, for permission to reproduce the diagram of the electromagnetic radiation spectrum illustrated in Figure 1.

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