USE OF ULTRAVIOLET LIGHT IN ARSON DETECTION

Ultraviolet light is a simple, reliable, cost effective method of arson detection that is too frequently over-looked in arson investigation. UV light not only assists in rapidly locating accelerant residues, it also assists in locating the point of origin of the fire. The color which accelerants glow is affected by heat exposure; the longer an accelerant is exposed to heat (i.e. the origin), the more differentiated its fluorescence color will be from other less exposed areas. Evidence of accelerants is almost always invisible to the naked eye after they have been absorbed in a fire. However, the areas tarnished by accelerants are easily discernible under UV light.

Volatile hydrocarbons such as gasoline, kerosene and other petroleum fractions, benzene, acetone, grease, lard, vegetable oils, paints, etc fluoresce when exposed to UV light. In addition, UV light can be helpful in locating fragments incendiary devices since explosive wrappings are frequently fluorescent. The use of UV light enables the investigator to accurately identify locations where samples should be collected for further laboratory analysis. Samples collected in cans and plastic evidence bags can then be heated in warm water to form condensation. Latent accelerant residue may then be brought to the surface and seen under UV light.

In order to successfully use UV light at a fire scene, ambient light must be reduced to a minimum. This can be done by covering widows and other exposed areas with an opaque sheeting such as black plastic.

It is important to put collected samples in a sealed airtight container and properly label the evidence (*date, where found and the mark of the investigator*) before dispatching and storing.

Ultraviolet light in comparison to "Sniffers"

UV lamps and sniffers are tools in arson detection, each of which aids the investigator. While it is not recommended that one of these tools be used in place of the other, there are advantages that UV light lends to an investigation:

- Use of UV light is not contingent upon wind conditions.
- The sniffer does not detect specific infected areas, but rather indicates a general area of saturation, making pour pattern sampling difficult.
- The sniffer is effective only two to three days after saturation, while UV lamps have been proven to effectively fluoresce samples up to two months after an incident.
- After a hot lengthy fire, the odors of accelerants are usually gone.

- A sniffer will often pick up false positives, such as human saliva as a positive identification of an accelerant

ARSON DETECTION

In arson detection, accelerants' fluorescent glow is greater when exposed longer to heat. Their evidence is not always visible as they are absorbed by the fire but UV light can expose them.

Volatile hydrocarbons such as gasoline, grease, paints and others fluoresce when exposed to UV, and can be seen as fragments of incendiary devices. Ambient light must be minimized for use of UV light at a fire scene.

Forestal, Raymond, E. Use of Ultraviolet Light in Fire/Arson, Bomb and Environmental Investigation. Firehouse. Vol. 19. No. 9 (September 1994). p 48-50.

Abstract: Ultraviolet (UV) light is the band of wavelengths between visible light and x-rays that cannot be seen by the human eye. The use of UV light is a reliable method of identifying the presence of accelerants. When certain substances are activated by UV light, they absorb energy which is manifested as fluorescence, or light. Substances that fluoresce under UV light include gasoline, kerosene, fuel oils and other petroleum fractions such as benzene. There are other substances that fluoresce as well, and investigators must determine when the presence of an accelerant is actually indicated.

UV light has been used to identify pour patterns, the shape of an accelerant container and pour trails leading back to containers. UV light will indicate accelerant long after its odor is discernable. Masking an accelerant will not prevent its UV detection. Accelerant on skin or clothing will fluoresce as well.

Areas illuminated by UV light can be photographed with slow shutter speeds, long exposure times, a tripod, and special film or filters. An I lux camera is an excellent tool for obtaining these images.

When using UV light, dual wave, portable, hand-held lights seem most effective. The area should be as dark as possible. Protective eyewear should be worn and you should not look at any UV light source without protection. Reflective surfaces exposed to UV light can cause sunburn to eyes and skin. And UV light is not to be used in explosive atmospheres. UV light does, however, assist in the location of explosive residues.

UV light can assist in environmental investigations by indicating the presence of hydrocarbons on land and in water. Illegal dumping has been traced using this technique. Trace dyes can be used along with UV light, and some radioactive substances fluoresce as well.

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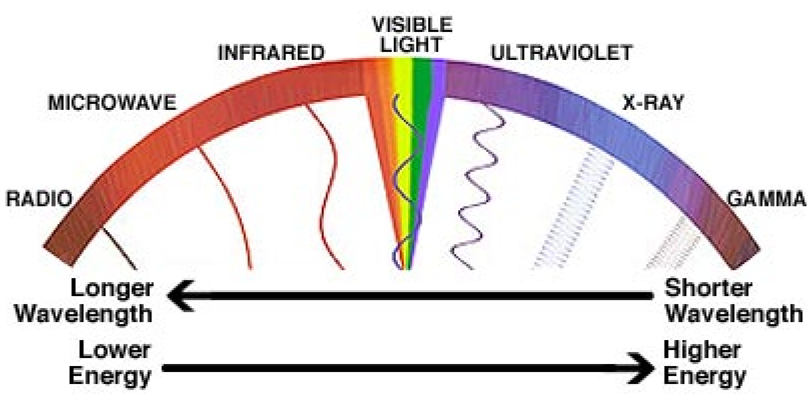
Ultraviolet or UV Light
an Introduction

The Electromagnetic (EM) Spectrum is simply a name scientists use when referring to the entire range of radiation types. Radiation is energy that travels and spreads out as it moves. Examples include visible light and radio waves. Other examples of EM radiation are ultraviolet and infrared light, microwaves, X-rays and gamma-rays.



Ultraviolet radiation is that part of the electromagnetic spectrum between visible light and x-rays. **Ultraviolet, or UV light**, is divided into three regions, based on wavelength. UVA, (know as longwave or blacklight), is radiation with wavelengths between 315nm and 400nm. UVB (midrange) spans wavelengths from 280 to 315nm and UVC (shortwave) covers 280nm down to about 30nm.

Shorter wavelengths of light are more energetic than longer wavelengths. Unlike x-rays, UV radiation has a low power of penetration, with effects on the body limited to skin and eyes. Direct and indirect exposure to UV, especially in the UVB and UVC range, include sunburn, aging and carcinogenic changes. UV protective eyewear, clothing and creams are recommended whenever exposure to UV is possible.

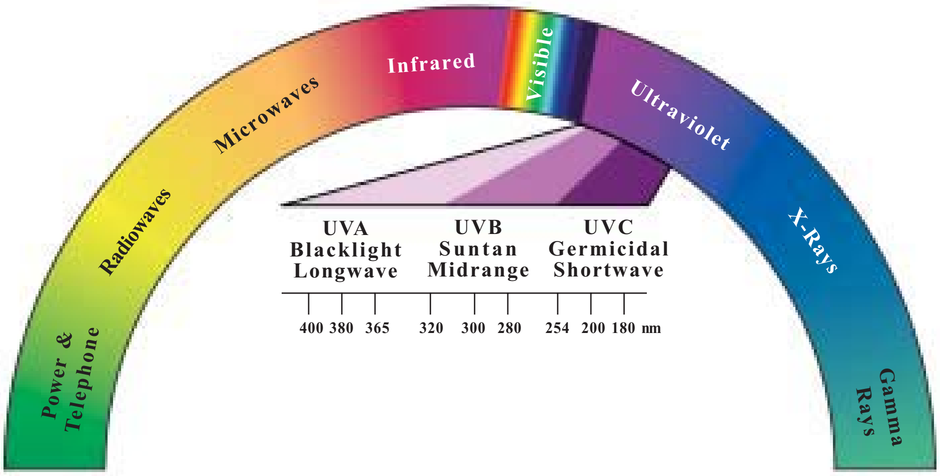
An interesting characteristic of UV radiation occurs when it falls upon certain substances know as phosphors (phosphorescent substance), where it causes the phosphors to emit specific visible radiation which is known as fluorescence. A similar effect is phosphorescence in which the emission lasts longer after the UV source is removed. Many practical applications have been developed that take advantage of these unique properties triggered by UV light.

ABOUT ULTRAVIOLET LIGHT

An important thing to know is that ultraviolet (UV) is not a single entity, but is a wide band of wavelengths within the electromagnetic spectrum.

The chief natural source of UV is the sun. In fact, about nine percent of all energy emitted by the sun is UV. Most of which is in the region between 300-400 nm. Artificial sources of UV include incandescent, gas discharge, low pressure mercury, medium pressure mercury metal halide, electrodeless and xenon lamps.

UV light is electromagnetic radiation in the part of the spectrum between x-rays and visible light. It differs from visible light only in that the UV wavelengths are too short to be seen by the human eye. The boundary between visible light and UV is a wavelength of 400 nm. Medical literature divides UV light into three ranges: UV-A (315 nm and higher), UV-B (280-315 nm) and UV-C (280 nm and lower).



An interesting characteristic of UV radiation occurs when it falls upon certain substances known as phosphors, where it causes the phosphors to emit specific radiation. This phenomenon is known as fluorescence. Everyday fluorescent lighting is basically a UV lamp constructed of a type of glass bulb that blocks UV rays. The inside of the bulb is coated with a thin layer of fluorescent material that receives UV generated by the lamp and in return emits a visible light.

One effect of UV energy upon certain substances is a phenomenon that takes place at the atomic level. High-frequency UV photons collide with atoms and part of the photon's energy is transferred to the atoms by boosting electrons to higher energy states.

Upon de-excitation, as electrons fall back to lower energy states, energy is released as photons of light. Since only a portion of the incoming photon's energy was transferred to an electron, these emitted photons have less energy than the incoming UV photons, so their wavelengths are longer than the excitation photons. This process is called fluorescence.

In some materials, the fluorescence lingers and disappears, slowing after the UV source is removed. Here, the electron returns slowly to its original energy state, and this delayed fluorescence is called phosphorescence. These unique properties of UV fluorescence and phosphorescence are but two of the many ultraviolet phenomena that make it vital to science and law enforcement.

Ultraviolet (UV) light sources are used at the crime scene and in the laboratory for the preliminary examination and location of physical evidence.

Ultraviolet (UV) light examination of physical evidence traces may yield valuable information toward the solving of many different crimes. Examination of physical evidence under UV light includes just about everything. Some of the more useful items are as follows: physiological fluids, glass and ceramics, petroleum products, fibers, hair, cosmetics, wood and botanical materials, minerals, gems, glues, adhesives, drugs, poisons, plastics, foodstuffs and arson debris.

Ultraviolet (UV) light is essential when utilizing fingerprint enhancement powders and dyes. Silver nitrate, physical developer and DFO development of fingerprints are enhanced with UV light. The use of fluorescent tracer powders, pastes and inks in conjunction with UV light enhance theft detection and security. Imagination is the only limiting factor.

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In order to successfully use UV light at a fire scene, ambient light must be reduced to a minimum. This can be done by covering windows and other exposed areas with an opaque sheeting such as black plastic. If that is not possible, a portable cabinet such as UVP's CC-10P allows you to put samples inside, turn on an attachable, portable UV light and view the specimen through UV protective lenses.

It is important to 1) put collected samples in a properly sealed air-tight container, and 2) properly label the evidence (date, where found, and the mark of the investigator), before dispatching and storing (under lock and key in the "property room") via the recommended procedure.

UV Light in Comparison to "Sniffers"

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USE OF ULTRAVIOLET LIGHT IN ARSON DETECTION

What is Ultraviolet Light?

Ultraviolet light is the band of wavelengths (electromagnetic radiation) between visible light and x-rays. It differs from visible light only that its wavelengths are too short to be seen by the human eye. Ultraviolet light is typically divided into three ranges:

UV-A (longwave) which is 315nm and above,
UV-B (mid-range) which is 280nm-315nm, and
UV-C (shortwave) which is 280nm and below.

The chief source of natural UV light is the sun. In fact, 9% of all energy emitted by the sun is ultraviolet, most of which is in the region of 300nm to 400nm.

How Does UV Light Work?

Fluorescence in many materials is caused by some impurity, frequently referred to as “activators”, or “activating agents”. All matter is made of atoms. All atoms are made of electrons which orbit around a nucleus. In the case of many accelerants, if these electrons are exposed to UV light, they absorb energy, move violently, and jump outward from their normal orbit. As they leave their orbit, another electron is pulled down from its orbit to maintain the electrical balance. This movement produces energy and it is this energy which is seen as fluorescence. Fluorescence occurs only while the material is being activated by ultraviolet light.

Phosphorescence occurs when a material retains and releases, in the form of visible light, some of the energy it receives during the period of activation called fluorescence, after the activating UV source has been removed. This released radiation following the period of activation may persist for periods from a quarter of a second to a matter of many hours. The light given off during phosphorescence is quite dim compared to fluorescence.

How to Get Started

Since accelerants respond to both shortwave and longwave UV, a portable, AC/DC lamp that is both shortwave and longwave lamp such as UVP’s UVSL-26P is ideal. Fully charged, it will operate continuously off the internal lead acid battery on the field for up to five hours. It can also operate off a wall outlet for laboratory use. For those who prefer to leave a six watt lamp in a vehicle for emergency use, the UVGL-48 is an excellent choice. It operates on two 6-volt lantern batteries.

When photographing/documenting fluorescence from an arson scene, use a one lux video camera (first choice) or a 35mm camera equipped with high speed color film.

Some sort of opaque covering, such as black plastic, will be needed to darken the room or area being searched. When reducing ambient light is not possible, a portable UV cabinet such as the UVP CC-10P will be needed to view samples for fluorescence.

When working with shortwave UV, use protective eye-wear such as UVP’s Blak-Ray® Goggles or Blak-Ray Spectacles.

Other Uses of UV Light in Forensics

UV can be of great assistance in bomb investigation. Many ingredients of explosives fluoresce, such as anfo, nitrates, sulfur, fuel oil, paraffins, and P.E.T.N. Metal fragments with traces of these residues can frequently be foun with the use of UV light as well as molotov cocktail type containers.