ULTRAVIOLET & INFRARED PHOTOGRAPHY

GUIDE

Ontario Police College
Identification Training

Module P-18

Revised: 1 Aug 97
1 Apr 98
1 Mar 99

Douglas S.B. Johnston
Subject Coordinator

Graeme B. George
Course Coordinator

INTRODUCTION

Forensic Identification Officers employ ultraviolet and infrared radiation to increase contrast between two or more pigmented materials when photographing certain evidence involving inks, dyes and stains. Ultraviolet fluorescence photography is used to photograph fingerprints developed with fluorescent powders. In this module you will learn the useable ranges of ultraviolet and infrared radiations in forensic photography and practice some of their applications.

PREREQUISITES

- P-1, P-2, P-3, P-8, P-16, P-5, P-6, P-7, P-19, P15

WHAT THIS MODULE CONTAINS

- GUIDE - this booklet, a resource guide
- ACTIVITIES - the booklet of practice activities
- ACTIVITY CHECK-OFF SHEET - a progress report
- CRITERION TEST - a test instrument

HOW TO WORK THROUGH THIS MODULE

- read the objective to discover what you will attain for your efforts
- gather the resources listed in this guide
- examine the Criterion Test to learn how you will provide evidence of attaining the objective
- start reading this guide and follow written instructions

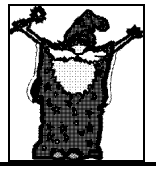
The material in the Guide and the Activities booklets, although integral parts of this training package, are by no means adequate by themselves to ensure success. Study the resource material. The resources have been carefully selected for their relevancy to the objective.

THINGS YOU WILL NEED

- copy and tripod
- 35mm camera kit and view camera
- panchromatic and infrared films
- B+W 403 UV-pass filter, 093 IR-pass filter, Cokin 001 and Kodak Wratten filters 2A, 8, 47, 29
- module exhibits

Caution: Protect your eyes! Wear ultraviolet-absorbing safety goggles. Do not look directly into a UV source. Short-wave and middle ultraviolet that cause sunburn and tanning may cause eye damage.

ULTRAVIOLET & INFRARED PHOTOGRAPHY



OBJECTIVE:

- Given camera, film, accessories and written materials, at the end of the session the student will be able to employ ultraviolet and infrared photography to the extent that the student will be able to: identify the photographic technique best suited to the subject for the intended outcome, select an appropriate radiation source for that technique, correctly install the filtration and film required, focus the image and produce an acceptable print of subjects photographed by reflected ultraviolet, ultraviolet fluorescence and reflected infrared radiation, as evaluated by the facilitator.

KEY CONCEPTS:

- ultraviolet wavelengths
- long wave, middle and short wave ultraviolet
- UV sources
- safety precautions
- applications for UV
- films for UV
- exciter and barrier filters
- fluorescence, phosphorescence and luminescence
- descriptions of reflected UV and UV fluorescence photography
- infrared wavelengths
- actinic, hot-object, calorific and warm infrared
- IR sources
- applications for IR
- films for IR
- exciter, barrier and IR colour film filters
- descriptions of reflected IR and IR luminescence photography

RESOURCES

Kodak Professional Databooks:

B-3, Kodak Filters for Scientific and Technical Uses

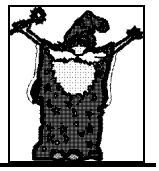
M-27, Ultraviolet and Fluorescence Photography

M-28, Applied Infrared Photography

Photographic Evidence, by Charles C. Scott, St. Paul, Minn., USA West Publishing Co., Second Edition, 1969. Volume 2, pages 60 - 115 incl.

Filters: Ultraviolet and infrared transmission filters are available from:

Daymen Photo Marketing Ltd
3241 Kennedy
Toronto ON M1V 2J8
www.daymen.com & www.lowpro.com
email: Info@daymen.com



AN OVERVIEW OF ULTRAVIOLET AND INFRARED

Ultraviolet and infrared have valuable application in law enforcement photography. Photography utilizing these radiations may provide information about an object or material which cannot be obtained by other photographic methods. Either or both could be considered as part of a physical examination in cases where visual examination or photography by normal processes fail.

The visible spectrum ranges from blue at 400nm to red at 700nm. Ultraviolet wavelengths are shorter than 400nm and infrared wavelengths are longer than 700nm. They provide us with no visual response and therefore are not considered to be light. Certain narrow bands of this invisible radiation, however, have practical photographic applications. Long wave ultraviolet and *actinic infrared*[1] can be used for photography with ordinary camera lenses.

All standard photographic papers and photographic films are sensitive to ultraviolet. They are not, however, sensitive to infrared. Special film, sensitized to infrared radiations, is required for infrared photography. This infrared film is also sensitive to blue-violet and to ultraviolet. Developing and printing techniques are similar to the normal processes for both ultraviolet and infrared photography.

Since ultraviolet and infrared enable one to photograph beyond the visible spectrum, the question arises when should one use ultraviolet photography and when infrared. There is no certain method for selecting one over the other. The good thing is that both processes are non-destructive to inanimate objects. For life forms, the usual precautions regarding exposure to the eyes should be heeded. In cases of uncertainty as to which technique might produce the best results, you may have to try all. In such cases the following order is suggested:

1. reflected ultraviolet light

2. ultraviolet fluorescence

3. reflected infrared

4. infrared luminescence.

[1] That part of the infrared spectrum that can be focused through a camera lens onto an infrared-sensitized emulsion which can be processed with conventional photographic materials.

What we mean by luminescence, fluorescence and phosphorescence:

LUMINESCENCE	**FLUORESCENCE**	**PHOSPHORESCENCE**
When certain materials (solids, liquids, or gasses) are subjected to short wave electromagnetic radiation, they will emit another radiation of longer wavelength very often in the visible spectrum. This phenomenon of induced light emission is called *luminescence* and there are two distinct types, known as *fluorescence* and *phosphorescence.*	If the luminescence ceases within a very short time (10^{-8} seconds) after the exciting radiation is removed, the phenomenon is called fluorescence.	There are some substances which continue to emit luminescence for some time, even hours, after removal of the exciting stimulus (e.g., TV screen, oscilloscope, certain chemicals and living organisms).

Filters

Filters employed in ultraviolet and infrared photography are identified by their function as described below.

- Exciter filter, placed in front of the radiation source, transmits a band of wavelengths chosen for its ability to cause a subject to luminesce in wave lengths longer than those of the exciting radiation.

- Barrier filter, placed in front of the camera lens, absorbs undesired wavelengths from reaching the film.

N.B. The same filter could be exciter or barrier depending on its placement within the set up of a particular process. For example, the B+W 403 UV-pass filter employed in ultraviolet fluorescence photography, becomes an *exciter* filter when placed in front of the source of the radiation, and a *barrier* filter when used in front of the camera lens in ultraviolet reflected photography.

ULTRAVIOLET PHOTOGRAPHY

Ultraviolet Radiation
For practical photographic purposes we use only the long wave ultraviolet band. A description of the three arbitrary divisions of the ultraviolet spectrum follows.

- ***Long wave ultraviolet*** is considered to extend from about 320 to 400 nanometres. This band is transmitted by regular optical glass, of which most photographic lenses are made and, therefore, is of most practical value in ultraviolet photography.

- ***Middle Ultraviolet*** includes radiations from about 280 to 320 nanometres. Part of this band of ultraviolet rays is included in sunlight, and is noted for its tanning action on human skin, sometimes causing sunburn. These rays are also emitted from "sunlamps". *Middle ultraviolet radiations are not transmitted by regular photographic lenses.* A lens made of quartz, however, will transmit middle and long wave ultraviolet and could therefore produce an image using them.

- ***Short wave ultraviolet***, sometimes called *far ultraviolet*, extends from about 200 to 280 nanometres in wavelength. It is notable for its germicidal effects but will also cause "sunburn" of unprotected eyes or skin.

Common Sources Of Ultraviolet Radiations
Long wave ultraviolet (320nm to 400nm), is emitted by the following common sources:

- electronic flash units
- fluorescent tubes (F15/T8 BLB) - G.E., Sylvania and Westinghouse
- purple-X bulb
- sunlight
- wire-filled flash bulbs
- mercury vapour lamps

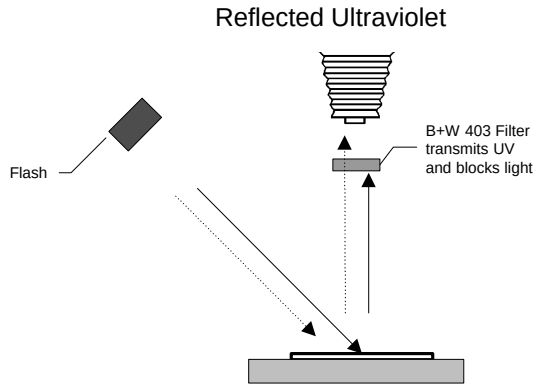
Caution: Protect your eyes! Wear ultraviolet-absorbing safety goggles. Do not look directly into a UV source. Short-wave and middle ultraviolet that cause sunburn and tanning may cause eye damage.

Whereas conventional photography may be thought of as recording what is visible in light, ultraviolet photography is based upon the premise that two or more elements of an object will reflect or absorb ultraviolet to different degrees thereby making detail visible in the photograph that was not visible to the eye previously. For example, writings made by two similar looking inks may show distinct differences in their brightnesses in an ultraviolet photograph.

Now, turn to the Activities booklet and complete Activity One.

REFLECTED ULTRAVIOLET PHOTOGRAPHY

Purpose:
To photograph a subject by reflected ultraviolet radiation.



What You Need:

- electronic flash or other long-wave UV radiation source
- camera
- B+W 403 UV-pass filter barrier filter[2] over camera lens
- panchromatic film

This diagram illustrates a subject set up for photographing by reflected ultraviolet. The **B+W 403 UV-pass filter** filter **transmits the ultraviolet provided by the electronic flash and** acts as a barrier by **absorbing the visible light which is also emitted by the flash unit.**

It is impossible to focus through a B+W 403 UV-pass filter but more critical focusing can be accomplished by focusing through a 47 filter and then replacing it with the B+W 403 UV-pass filter just before making the exposure.

[2] ***Barrier Filter*** is the name given to the filter used *in front of the lens of the camera.* Its function is *to absorb* unwanted radiation (in this case, light) emitted by the source, and *to transmit* the desired radiation (ultraviolet) reflected by the subject. A Kodak Wratten 18A filter could be substituted for the B+W 403.

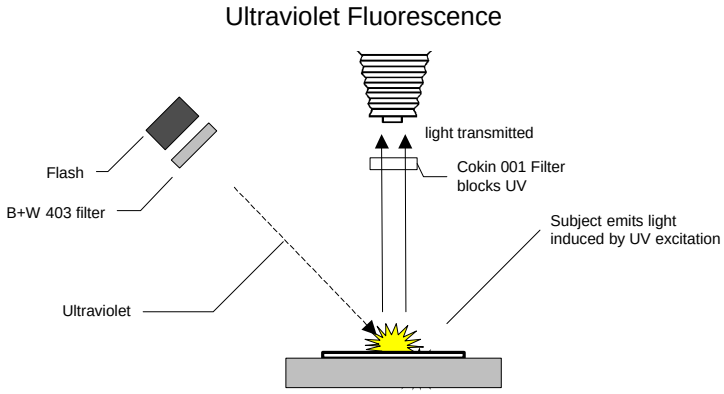
Uses Of Reflected Ultraviolet

May increase contrast of:	
blood	situations where its colour blends with surroundings
documents	erasures, forgeries and faded documents inks and typewriter ribbons - pigments vary in the absorption and reflection of ultraviolet
paints	touch-ups as pigments vary in the absorption and reflection of ultraviolet
skin conditions	dermatology

Now, turn to the Activities booklet and complete Activity Two.

ULTRAVIOLET FLUORESCENCE PHOTOGRAPHY

Purpose:
To photograph a subject by the induced light emitted from that subject when it is excited by ultraviolet radiation.



What You Need:
- electronic flash or other long-wave UV radiation source
- camera
- **exciter filter**[3] such as a B+W **403** UV-pass filter, Kodak Wratten **18A** or a Corning **5840** filter over the UV source
- **barrier filter,** *in order of increasing blue absorption*, Kodak Wratten filters **2b, 2a, 3, 4, 8, 9, 12, 15.** A Cokin 001 filter may be substituted for the Wratten 8.
- panchromatic film
- fluorescent powder

Ultraviolet light **excites** a suitable fluorescent subject. It may be assumed that in addition to the visible fluorescence, there will also be ultraviolet reflected toward the camera lens. A filter, such as a **2A**, creates a **barrier to the ultraviolet by absorbing it while it transmits the visible fluorescence.**

Focusing is accomplished in the normal manner. If you are using electronic flash and a shutter speed fast enough to exclude exposure by any ambient light *then total darkness is not required*. When a continuous radiation source, such as a Purple-X bulb is substituted for electronic flash, exposures must be made in a darkened room to ensure film is exposed only to the fluorescence.

Film emulsion speeds and focal lengths of camera lenses pertain to light and do not apply to UV or IR radiation. Exposure tests are recommended to establish film exposure index,

[3] ***Exciter Filter*** is the name given to the filter used *in front of the source of the radiation.* Its function is *to transmit* the exciting radiation and *to absorb* all, or nearly all, other radiation emitted by the source.

selection of aperture and shutter speed. This exposure index can then be applied to an exposure meter.

Uses Of Ultraviolet Fluorescence

May increase contrast of:	
blood	situations where its colour blends with surroundings
documents	erasures, forgeries and faded documents inks and typewriter ribbons - pigments vary in the absorption and reflection of ultraviolet
invisible Stains	various body secretions, such as: urine, semen, pus, perspiration, etc., as they often emit a particular fluorescence
clothing	white clothing particularly may fluoresce an intense white-blue because of blue-white fluorescent dyes used in laundry detergents to make clothing look whiter and brighter. The use of ultraviolet lights under water has been suggested as an aid in locating human bodies because of this common fluorescence of clothing.
fingerprints	on multicoloured backgrounds; shiny or concave object; organic matter (all using fluorescent fingerprint powders).
sneak detection chemicals	in secret marking of objects - powders, pastes, inks, pencils, coin lacquers. (All of these aids must be fluorescent - sold by police supply houses.)

Now, turn to the Activities booklet and complete Activity Three.

INFRARED PHOTOGRAPHY

Thermography
Thermography is the name given to a family of infrared imaging systems that convert variations in infrared radiation from 700 nanometres to least 14,000 nanometres into a visual display. These displays may then be photographed by conventional methods and film materials. This technique requires sophisticated instruments not generally affordable by forensic identification sections.

There are several ranges of infrared: actinic, hot-object, calorific and warm. We are interested in the actinic range from 700nm to 900nm.

Actinic Infrared
Actinic infrared photography can be defined as the technique of using a camera lens to focus and expose an infrared image on an emulsion sensitized to infrared radiation.

For a subject to be photographed in this manner it must:
- reflect or transmit infrared radiation or
- the subject must luminesce in the infrared region

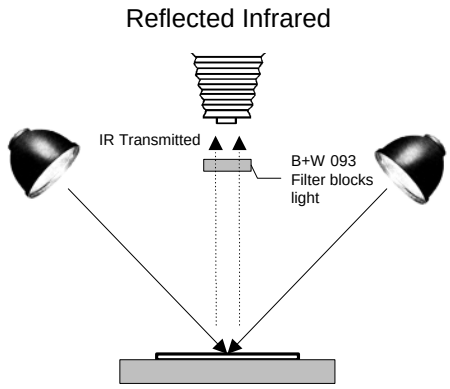
Luminescence of a suitable subject occurs when it is illuminated with the shorter wavelengths of visible light or ultraviolet radiation.

Common Sources of Infrared Radiations
- electronic flash units
- tungsten lamps
- white fluorescent tubes
- sunlight

NOTE: Infrared heat lamps are primarily designed for radiation in the hot-object range between 900 to 2500nm and therefore are better suited for therapy than for IR photography.

REFLECTED INFRARED PHOTOGRAPHY

Purpose:
To photograph a subject by reflected infrared radiation.



What You Need:

- electronic flash or other actinic IR radiation source
- camera
- B+W 093 IR-pass filter[4] acts as a barrier filter over camera lens (*see Kodak's Applied Infrared Photography,M-28, for other filters which could be used*)
- fast infrared film (*if infrared colour film is used a 12 barrier filter must be employed*).

Here, we wish simply to photograph a subject by the infrared it reflects. To ensure the film is exposed by infrared only, a B+W 093 filter is placed on the camera lens, this filter will absorb all light but transmit infrared.

The lens focal length required for infrared photography must be adjusted slightly longer than required for visible light. A smaller lens opening, e.g., f 22 offers added sharpness.

Note: Use a 25 or 29 filter while focusing:
It is impossible to focus through an infrared-pass filter but more critical focusing can be accomplished by focusing through a Kodak Wratten 25 or 29 filter, then replacing it with an IR-pass filter prior to exposure.

Caution: Hollow-core darkroom doors may transmit infrared through the air cells of the plywood and therefore may not be safe.

[4] A Kodak Wratten 87 filter may be substituted.

Uses Of Reflected Infrared

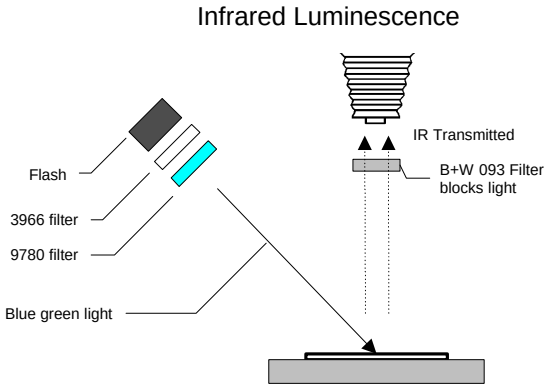
May increase contrast of:	
blood	situations where its colour blends with surroundings
documents	erasures, forgeries and faded documents inks and typewriter ribbons - pigments vary in the absorption and reflection of ultraviolet
dyes and other pigments	touch-ups - as pigments vary in the absorption and reflection of ultraviolet
subjects in atmospheric haze	appears to penetrate haze
gun shot wounds	to illustrate powder burns
other wounds	to show subcutaneous tissue damage and haemorrhaging
stains and other irregularities	in cloth and other materials
cloth, hair and fibre examinations	may show differences among like subjects by differences in reflection or luminescence capabilities
secret writings	will sometimes reveal contents
sealed envelopes	will sometimes reveal contents
photography in the dark	surveillance - limited application
plants and foliage	may show differences among like subjects by differences in reflection or luminescence capabilities

NOTE: This field is still being explored. During your career, experiment with infrared to find additional applications.

Now, turn to the Activities booklet and complete Activity Four.

INFRARED LUMINESCENCE PHOTOGRAPHY

This application is available on request through the Centre of Forensic Sciences. It is generally considered not a cost effective one for most police services given the cost of filters and the number of occasions the technique may be used. The technique will, however, be described.



Purpose:
To photograph a subject by its induced infrared emission when excited by a blue-green light transmitted by a Corning blue-green filter 9780.

What You Need:
- electronic flash or any conventional light source
- camera
- 9780 Corning filter (blue-green) exciter
- 3966 Corning heat-absorbing filter between light source and 9780 filter
- B+W 093 barrier filter over camera lens
- fast infrared film

It is possible to excite luminescence in infrared by irradiating a suitable subject with blue-green light. The phenomenon is referred to as **luminescence** because it is not known whether the effect ceases immediately after the exciting stimulus is removed.

We can see that the 9780 filter transmits a blue-green light. This wavelength will excite a suitable luminescent subject which, in turn, will emit its own radiation in the form of infrared. Because we want a photograph of the subject's luminescence and not a photograph by reflected light, a B+W 093 barrier filter is employed over the camera lens to absorb the reflected blue-green light and to transmit only the infrared.

Uses Of Infrared Luminescence

May increase contrast of:	
documents	alterations (where original script has been tampered with)
inks	visualizing differences seemingly identical to the naked eye
dyes and other pigments	certain substances luminesce when exposed to infrared stimulation (sometimes they may be identified by their degree of luminescence)

If you have the necessary equipment, experiment with infrared luminescence to find other practical applications.

NOTES