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Visible and Infrared Luminescence in Documents: Excitation by Laser

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ABSTRACT: The use of the argon laser in the crime laboratory can be extended from the detection of latent fingerprints to include document examination. With appropriate filters, both visible and infrared luminescence can be recorded under argon laser excitation.

KEYWORDS: questioned documents, lasers, luminescence, filters, argon lasers

The application of the argon laser to fingerprint detection has been well documented [*1-3*]. Exhibits are placed under the expanded beam of an argon-ion laser (multi-line) and luminescence of fingerprints may be seen and photographed by use of an appropriate barrier filter at the eye or camera.

Creer [*4*] reports positive results in document examination using single-line excitation in combination with a yellow filter. Alterations and obliterations on documents are often unreadable or undetectable in visible light viewing. When examined with a specific combination of light source and barrier filter, however, they often reveal this hidden evidence.

Two such cases are described below, each displaying a different technique of examination. In both cases a Spectra-Physics Model 171-8 15-W argon ion laser was used. In Case 1, the light source and filter combination were identical to that initially used in fingerprint detection. In Case 2, the argon laser was used to excite infrared luminescence [*2*].

Recording of infrared luminescence as previously documented [*5*] consists of a light source with an exciter filter which transmits blue-green wavelengths and absorbs red and infrared. A Corning 9780 filter is routinely used for this purpose. A barrier filter which transmits only infrared wavelengths [*6*] is used at the camera lens to isolate desirable luminescence from reflected visible light. The exciter filters must not leak visible light from the source. Also, a Corning 3966 heat-absorbing filter must be used between the light source and the filter to protect it from heat.

The argon laser can be used to excite infrared luminescence in lieu of the light source/filter combination described above. As shown in Fig. 1, the spectral lines produced by the argon laser are located ideally within the transmission spectrum of the 9780 filter.

Case 1

A large number of postal meter impressions was received in the course of a fraud-theft investigation. On the first digit of the amount on the meter impression a date stamp had been

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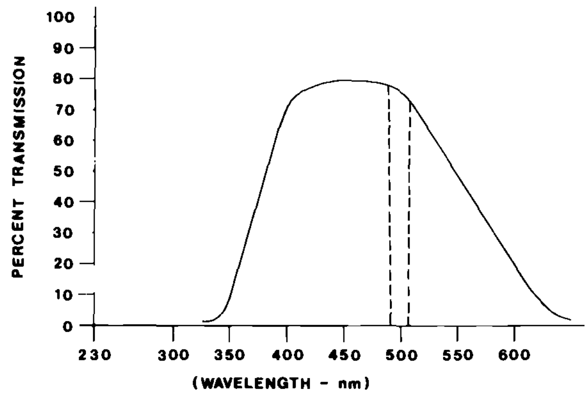

FIG. 1—*Transmission spectrum of Corning 9780 filter (——) and major wavelengths produced by the argon laser (----).*

placed, obliterating the digit with black ink. The area of the digit had been further obscured with a black felt marker. The suspect claimed that the hidden digit in each of these meter impressions was a "9." A "0" or "*" in the first digit position would reveal a discrepancy of $9.00 for each obliteration.

Several exhibits were examined microscopically and photographically, including infrared and ultraviolet techniques. They were then subjected to applications of toluene, xylene, and acetone in attempts to dissolve the overlying black material that obscured the digit. All of the above procedures failed to reveal the hidden digit.

Another group of similar obliterations from the same investigation was submitted for examination by argon laser. The luminescence was viewed through goggles bearing the filters which were Fisher 11-409-50A. In 31 of 36 obliterations the hidden digit was readily visible as an asterisk. Figure 2*a* and *b* show the visible and laser recordings, respectively, of one obliteration. The obliterated asterisks were recorded on Ilford FP4® film. It was developed in Kodak D-11® developer for 4 min at 20°C with continuous agitation. The obliterations were also recorded on Kodak Vericolor Type VPL® film, exposed and developed as per the data

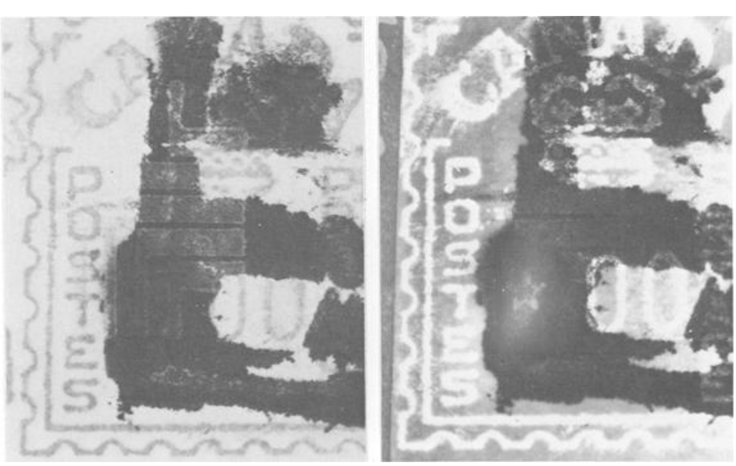

FIG. 2—*Obliterated postal meter stamp photographed in* (left) *white light and* (right) *laser light.*

sheet. The color recordings were much more effective than the black and white because the red color of the asterisk could clearly be seen against the black.

In both the color and black and white recordings the barrier filter at the camera lens was a Fisher 11-409-50A, from the goggles used for viewing. This is a cutoff filter transmitting wavelengths of approximately 530 nm and longer with an optical density exceeding 7 at argon laser wavelengths. Any filter that blocks the reflected laser light but transmits the luminescence wavelengths could be used in place of the Fisher goggles filter, which was originally intended to protect the eyes from argon laser light. Exposure was determined with a Pentax Digital Spotmeter by reading directly through the 11-409-50A filter.

A further submission of similar exhibits that was examined by infrared luminescence did reveal several asterisks, but not as many or with as great clarity as the technique described above.

As a result of this evidence, appropriate charges were laid against the suspect and a conviction was subsequently obtained.

Case 2

A lottery ticket was submitted by a person claiming a minor prize for matching the last three digits of the winning number. These three digits had been very heavily circled with ballpoint pen, the thickness of the circle being 2 to 3 mm. The ballpoint circle was carefully examined in room light and by laser, viewing through the filter goggles, 11-409-50A. No trace of detail under the ballpoint ink could be detected (Fig. 3*a*).

The exhibit was then irradiated with 10-W (all-lines) argon laser. Using a Kodak 87C Wratten filter as a barrier filter at the lends of the camera, an infrared luminescence recording was made on Kodak High Speed Infrared Film. The camera was stopped down to *f*-11 to yield sufficient depth of field for infrared focus. The optimum exposure was 20 min. The infrared luminescence recording clearly revealed the actual final digit "4" under the heavy ballpoint ink circle (Fig. 3*b*).

Discussion

It is not the intention of the writer to suggest the purchase of an argon laser for document examination by infrared luminescence, but rather to illustrate the extended utility of the equipment beyond fingerprint detection.

Laser-induced infrared luminescence does, however, offer certain advantages in this ex-

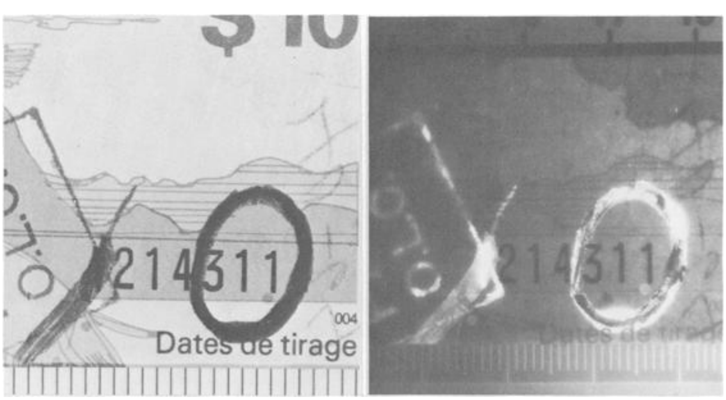

FIG. 3—*Altered lottery ticket,* (left) *white light photograph and* (right) *infrared luminescence recording.*

amination of documents over conventional techniques. As all wavelengths produced by the argon laser fall within the transmission spectrum of the Corning 9780 filter (Fig. 1), an exciter filter, and hence a heat-absorbing filter, are not required. Photography of infrared luminescence can be accomplished by simply darkening the room as for routine laser photography.

Power

A simple comparison was made between the comparitive power outputs of the Spectra-Physics Model 171-8 argon laser and the Vivitar Model 283 Electronic Flash (2900 BCPS), fitted with a Corning 9780 filter. (This is a flash and filter combination that has been used by the writer in the past to excite infrared luminescence.) The measurements were taken with a Minolta Multi-function 3 Flash Meter for flash or continuous light sources. The meter was placed 25 cm from the flash unit and a reading [7] was taken with the flash on manual setting, maximum power output. When the laser output was read, the meter was placed 25 cm from the point of beam expansion. In each case the setting for film speed was the same. The laser power was 20.5 W. Table 1 shows the result of this comparison.

Note that there is a difference in intensity between the two sources (as per these readings) of one stop. As the flash duration of the Vivitar 283 on manual setting is 1/1000 s [*8*], it can be seen that 2000 flashes would be required to equal the intensity of the laser (a continuous source) *in one second*. This comparison is not intended to present the argon laser as the ideal excitation source for infrared luminescence or to negate the flash-filter combination mentioned above, but rather to illustrate that the laser represents a powerful excitation source for this technique and that the length of photographic exposures can be kept to a minimum. Infrared recordings made by the writer in the past have entailed time exposures of many hours. Using argon laser excitation, similar recordings have been made with exposures of 15 to 30 min.

Conclusions

1. Argon laser examination can reveal useful luminescence in the visible spectrum during the examination of altered or obliterated documents.
2. The argon laser can be converted from fingerprint detection to recording of infrared luminescence of documents by simply changing the filter at the camera lens.
3. The Spectra-Physics 9-W argon laser in testing emits sufficient power that exposures for recording infrared luminescence are relatively short.
4. It is the writer's opinion, in concurrence with Creer [*4*], that more applications in the forensic science laboratory will continue to be discovered for the argon laser.

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TABLE 1—*Comparison of light intensity between Spectra-Physics Model 171-8 argon ion laser and Vivitar Model 283 Automatic Electronic Flash.*

	Distance, cm	Exposure	Film Speed, ASA
Laser	25	*f*-32 at 1/30 s	12
Flash	25	*f*-22 at 1/30 s	12

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