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TECHNICAL NOTE

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Laser Detection of Latent Fingerprints—Treatment with Fluorescers

In 1976 a method for the detection of latent fingerprints by their inherent luminescence using continuous-wave (CW) argon-ion laser excitation [1] was discovered at Xerox Research Centre of Canada, where the first detection by this method of an identified print from an actual criminal exhibit (a fingerprint on the sticky side of a piece of black electrical tape) was also achieved. Basically, the laser procedure involves illumination of the exhibit under scrutiny with the blue-green light from the argon-ion laser and photography of the resulting yellow-green fingerprint luminescence. The viewing and photography are carried out in a darkened room. A filter is used to block the laser light scattered from the exhibit to prevent eye damage and film exposure by the laser light. Spectroscopic and chromatographic features of fingerprint material indicate that riboflavin is one of several inherent luminescers in fingerprint residue and our findings suggest potential for fingerprint age determination [2].

While the laser method had wide applicability, it failed in a number of instances because of one of three reasons:

1. The substrate luminesced strongly, overwhelming the usually weak inherent fingerprint luminescence.
2. The substrate did not accept the fingerprint sufficiently well.
3. Fingerprints deposited by a minority of individuals did not show sufficient inherent luminescence.

To extend the application of laser detection to cases falling into these categories, we have explored several procedures for treating exhibits with luminescent material or with chemicals that react with fingerprint residue to form luminescent products. A staining procedure using coumarin 6, a laser dye, has already been described [1]. In this paper we report a procedure involving dusting with luminescent powders. The use of luminescent powder is particularly convenient, since one has two simultaneous, simple procedures on hand. Should no ridge detail be apparent on customary examination of the dusted exhibit, then laser illumination together with viewing and photography through suitable filters may bring out elusive latent prints.

Furthermore, we describe the application of two chemical treatments of latent prints, which are enhanced in sensitivity when used in conjunction with the laser method.

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Dusting with Luminescent Powders

Mars Red Hi-Intensity latent fingerprint powder, manufactured by Criminal Research Products, Inc., was selected for dusting because its red color indicated that it should absorb argon-ion laser light quite well. Upon argon-ion laser illumination the Mars Red powder showed a vivid red luminescence that permitted detection of fingerprints on dusted exhibits when they could not be seen in room light. Figure 1 shows such a fingerprint on paper. The print was photographed through a red Ealing 26-4432 filter with Polaroid film.

The significance of this procedure became apparent during examination of murder case exhibits brought to us by the Royal Canadian Mounted Police. Direct laser examination of a .22-caliber rifle, the suspected murder weapon, revealed no fingerprints. The varnished-wood gun stock luminesced strongly under the laser, overwhelming any possible weak fingerprint luminescence. The stock was therefore dusted with Mars Red. Still, no fingerprints were discernible on inspection in room light. The stock was then examined under argon-ion laser light. The print shown in Fig. 2, clearly visible on viewing through red filters, was photographed.

A number of substrates luminesce strongly on argon-ion laser illumination. Very often this luminescence (for instance, from some types of paper, cardboard, and wood) is yellow-orange. If the fluorescent material used to treat the exhibit luminesces in a spectral region in which little or no substrate luminescence occurs, then suitable band-pass filters can permit long photographic exposures (tens of minutes) to reveal very faint fingerprints.

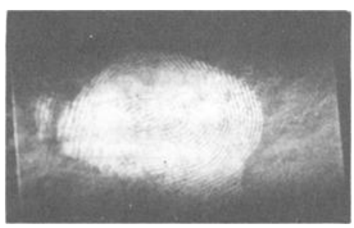

FIG. 1—*Latent fingerprint on paper dusted with Mars Red and detected by argon-ion laser.*

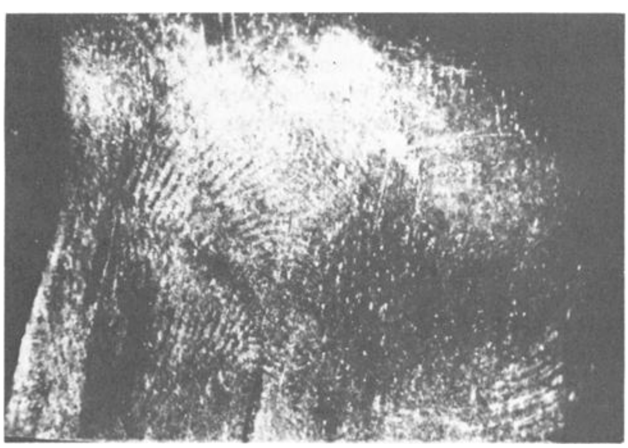

FIG. 2—*Latent print on gun stock dusted with Mars Red and detected by argon-ion laser.*

Normal photography does not have this feature because the light reaching the camera is scattered from the latent print and the substrate. The strong red emission from Mars Red has proven to be suitable for most substrates studied by us to date.

We have also identified a number of other pigments that possess the strong red luminescence necessary for the technique. One of these, Red Lake C, PDR-196 (available from Chemetron Corp., Holland, Mich.), a barium-laked arylazo-2-naphthol pigment blended with 45% hydrocarbon resin, was investigated in some detail. This material appears to be a good dusting powder, comparable to Mars Red in adherence, and examination of similarly treated prints under the laser indicated that it is slightly more luminescent than Mars Red. The relative luminescence strengths were more quantitatively compared with a Perkin-Elmer MPF-4 fluorescence spectrophotometer. Figure 3 shows the luminescences of both powders deposited to comparable density on paper. Excitation was at 514.5 nm, which corresponds to the strongest argon-ion laser line. The spectra indicate that PDR-196 luminesces about three times more strongly than Mars Red.

We have been informed by the Royal Canadian Mounted Police that Mars Red is not widely used as a dusting powder because of precautions necessary (but easily made) owing to its toxicity. Unfortunately, PDR-196, being a barium salt, is also poisonous [3]. We therefore examined two other pigments of the arylazo-2-naphthol class that should be less hazardous. One of these, Naphthol Red B (NRB), obtained from American Cyanamid, an unlaked (metal-free) pigment, showed a red luminescence spectrum comparable in intensity to that of Mars Red, but 10 nm red-shifted. The other, calcium-laked 2′-naphthylazo-1-bromo-2-naphthol-1′-sulfonate [4], which we abbreviate as CNBNS, showed a luminescence spectrum approximately a factor of two weaker than that of Mars Red. These spectra are also shown in Fig. 3. The two pigments were used in raw form and thus did not possess the good adhesion qualities of Mars Red and PDR-196, which are specially compounded with resins. Nonetheless, visual inspection under laser of similar exhibits dusted with all four materials did not show dramatic differences in fingerprint

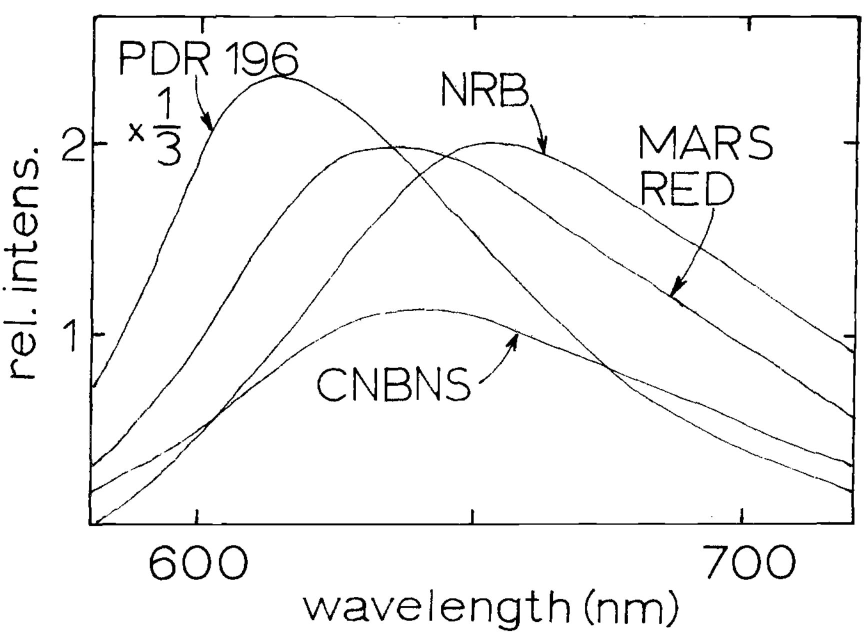

FIG. 3—*Comparison of the luminescence spectra of Mars Red, PDR-196, NRB, and CNBNS. The intensity for PDR-196 is shown reduced by a factor of three.*

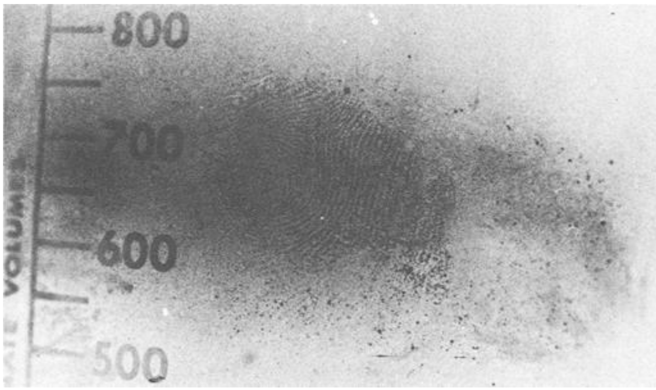

FIG. 4—*Latent fingerprint (on glass) treated with PDMAC and developed by argon-ion laser.*

luminescence features. We are thus led to suspect that most arylazo-2-naphthol pigments could be used to prepare dusting powders well suited to the laser method. In instances in which the substrate exhibits red luminescence, yellow- or green-luminescing dusting powders can be employed. For example, the powder in common vitamin B capsules adheres well to latent prints and exhibits a yellow fluorescence readily detected on argon-ion laser illumination. We expect as well that laser dyes, such as coumarin 6 and the rhodamines, suitably compounded with resin, should be very useful.

Treatments Yielding Luminescent Reaction Products

A latent fingerprint treatment analogous to the ninhydrin method, involving *para*-dimethylaminocinnamaldehyde (PDMAC), has been reported by Morris [*5*]. Fluorescamine, also known as Fluram® (Roche Diagnostics), is a well-known reagent for assay of amino acids which has been used in the detection of latent fingerprints for a number of years [*6*].

Fluorescamine-treated latent prints are rendered visible by illumination with an ultraviolet (UV) lamp. Yellow-green luminescence is observed. Since UV illumination is required, one would not expect fluorescamine to be useful in conjunction with argon-ion lasers. However, when argon-ion lasers are equipped with an UV option, which is easily interchangeable with the laser mirrors used for blue-green lasing, substantial power in the 333.6- to 363.8-nm range is provided. We are greatly indebted to Dr. C. W. Melton (Battelle Columbus Laboratories) for bringing the PDMAC method to our attention, and we understand that he has carried out extensive research for the Federal Bureau of Investigation on optimizing this method as well as the fluorescamine procedure. Our interest in these two techniques was aimed at determining whether their detectability can be enhanced with argon-ion laser illumination. Indeed, on a number of exhibits treated with PDMAC, fingerprints not discernible in room light were detectable under the argon-ion laser by their orange luminescence. One such fingerprint is shown in Fig. 4. Latent prints treated with *ortho*-phthalaldehyde [*6*] behave similarly. Fluorescamine-treated exhibits were examined with an argon-ion laser equipped with the UV option (10 mW laser power in the 333.6- to 363.8-nm spectral region). Fingerprints were readily detected. One such print is shown in Fig. 5. Comparison was made with exhibit illumination by a 150-W mercury UV lamp, which yielded slightly brighter luminescence. However, argon-ion lasers can provide large powers in the UV range. For example, a Coherent Associates CR-12 laser provides about 1.5-W UV laser power. We thus anticipate fine detectability using the fluorescamine treatment together with moderately powerful argon-ion lasers equipped with the UV option.

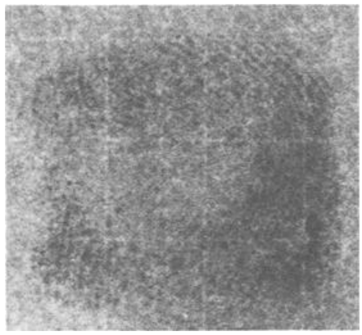

FIG. 5—*Latent fingerprint (on paper) treated with fluorescamine and developed by argon-ion laser equipped with UV option.*

Finally, we note that our earlier reported chromatographic and spectroscopic studies on fingerprint material [2] suggest the feasibility of photochemical reactions leading to luminescent products being detectable with an argon-ion laser. We are currently pursuing this direction.

We believe that these chemical reaction treatments, dye staining procedures, and dusting methods (undoubtedly other methods will be discovered), together with direct laser detection via inherent fingerprint luminescence, impart the laser method such a wide scope of utility that it will become very valuable to forensic analysts.

Acknowledgment

We thank Dr. Carl W. Melton for providing us with a sample of *para*-dimethylaminocinnamaldehyde and a sample of fluorescamine.

References

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