TECHNICAL NOTE

D. W. Herod,[1] *B.S. and E. R. Menzel,*[1] *Ph.D.*

Laser Detection of Latent Fingerprints: Ninhydrin

REFERENCE: Herod, D. W. and Menzel, E. R., "**Laser Detection of Latent Fingerprints: Ninhydrin,**" *Journal of Forensic Sciences,* JFSCA, Vol. 27, No. 1, Jan. 1982, pp. 200-204.

ABSTRACT: Ninhydrin-treated latent fingerprints not discernible in the conventional way can show fluorescence in the red and near-infrared spectral regions when subjected to continuous-wave dye laser illumination at about 580 nm, thus becoming amenable to development.

KEYWORDS: criminalistics, fingerprints, lasers, ninhydrin

The use of lasers for the development of latent fingerprints was first reported in 1977 [*1*]. The initial focus was on detection via the inherent luminescence of fingerprint residue excited by argon-laser illumination. Even in the very early stages of research it was recognized that detection by inherent fingerprint luminescence was of somewhat limited value since background luminescence from surfaces holding latent prints often overwhelms the inherent fingerprint luminescence. To permit use of the laser method in such instances, a variety of procedures were soon explored. These include dusting with fluorescent [*2-5*] or phosphorescent [*6*] powders, staining with fluorescent dyes [*1,5*], and treatments involving chemicals such as fluorescamine, *ortho*-phthalaldehyde and *para*-dimethylaminocinnamaldehyde, which react with fingerprint residue to form luminescent products detectable by argon laser [*2,5*]. More recently, latent fingerprint development by vapor deposition of fluorescent compounds has been reported [*7*].

Several uses of lasers other than fingerprint development have been reported since 1977 in forensic science work. These include reconstruction of fractured glass [*8*], document examination [*5,9*], and fiber analysis [*10*]. Such applications, together with latent print development, suggest that lasers may become commonplace in forensic science laboratories. At present, however, only very few law enforcement agencies employ lasers for fingerprint detection. Moreover, laser development of latent prints is often attempted only by search for inherent fingerprint luminescence. The dusting, staining, and chemical treatments cited earlier are not frequently used, perhaps because insufficient optimization work has been done to determine which of the many options is best suited to the particular instance a latent print examiner might be dealing with. Thus, the success rate of the laser method in criminal cases has so far perhaps been somewhat disappointing, and law enforcement agencies may be reluctant to acquire argon lasers, which are expensive, because they understandably have reservations about the cost-effectiveness of the method. In this paper, we report a new laser procedure that will help to eliminate this reservation, albeit at some additional cost.

Received for publication 20 April 1981; accepted for publication 10 June 1981.

[1] Graduate student and assistant professor, respectively, Department of Physics, Texas Tech University, Lubbock, TX 79409.

Laser procedures can certainly develop latent prints intractable to present-day routine methods, such as dusting, iodine fuming, and the use of silver nitrate or ninhydrin. However, there are far too many instances in which ninhydrin, possibly the best overall conventional method, develops prints that elude laser examination [*5,11*]. In the ensuing description, we report the combination of laser examination with ninhydrin treatment. If latent prints treated with ninhydrin are not discernible in the traditional way, they can be brought out by laser examination. Thus, a substantial increase in detectability is achieved.

Experimental Procedure

We have investigated the fluorescence of ninhydrin-treated latent fingerprints. Our findings are as follows. Well-developed prints, that is, those clearly visible in room light by their purple-blue color, do not show significant fluorescence under blue-green or near-ultraviolet (330 to 360 nm) argon laser illumination. While such prints can display fluorescence in the red and near-infrared regions under yellow or orange (570 to 590 nm) dye laser illumination, the fluorescence is generally rather weak and overwhelmed by background fluorescence from the surfaces holding the prints. Curiously, however, ninhydrin-treated prints that are not sufficiently developed to be discernible in room light by purple-blue color often show red and near-infrared fluorescence well above the background under similar dye laser illumination. No appreciable fluorescence is observed for such prints under blue-green or ultraviolet argon laser light. We find that 570- to 590-nm dye laser illumination generally yields the most clearly observable red fluorescence of such prints. This is a very convenient illumination range since it corresponds to near-peak efficiency of Rhodamine 6G, which, in turn, is the most efficient laser dye for continuous-wave (CW) dye lasers pumped by argon lasers. The compound that gives the red and near-infrared fluorescence observed under dye laser light from ninhydrin-treated prints that do not develop sufficiently to be visible in room light is not the same compound which causes the purple-blue ridge detail in well-developed prints. Instead, it is a reaction byproduct or an intermediate product.

The laser detection of ninhydrin-treated latent fingerprints is straightforward. The argon laser operates in the all-lines blue-green mode. The argon laser beam impinges on the CW dye laser (such as Spectra Physics Model 375) operating with Rhodamine 6G, causing tunable dye lasing. The dye laser wavelength is tuned to about 580 nm and illuminates the ninhydrin-treated surface under scrutiny. The surface is visually examined in a darkened room through goggles equipped with filters, such as Oriel G 772-6300, which block the laser light scattered from the examined surface but which transmit the desired fluorescence.

Once a latent print is visually observed, it is photographed through the same filter with red- or near-infrared-sensitive film. We have used Tri-X Pan, HIE black-and-white infrared, and Ektachrome (ASA 400) color slide film. Our experience indicates that the Tri-X Pan film with the above filter gives poor contrast. The HIE film, with an Oriel G 772-7000 filter, which transmits only infrared, provides considerably better contrast but often does not show detail as good as that seen on inspection. Our best results have been obtained with the color film.

Figures 1 and 2 show, respectively, a ninhydrin-treated piece of galvanized metal in room light and a latent fingerprint on it not discernible in room light but developed under the dye laser. The all-lines blue-green argon laser power was 4.5 W (the limit of our laser, Spectra Physics Model 164-05), yielding about 1 W of 580-nm dye laser power. Figure 3 shows our argon/dye laser system. A 20-W argon laser would yield roughly 5 W of dye laser power, thus strongly increasing sensitivity over that of our instrumentation, which is just adequate for latent print development.

We have examined latent prints older than one day on a variety of surfaces (paper, plastics, metals, and glass) sprayed with methanol solutions of ninhydrin. Latent prints visible in room light developed over one or two days without heating. In many cases, we observed additional prints, not seen in room light, under the dye laser. These additional prints also developed

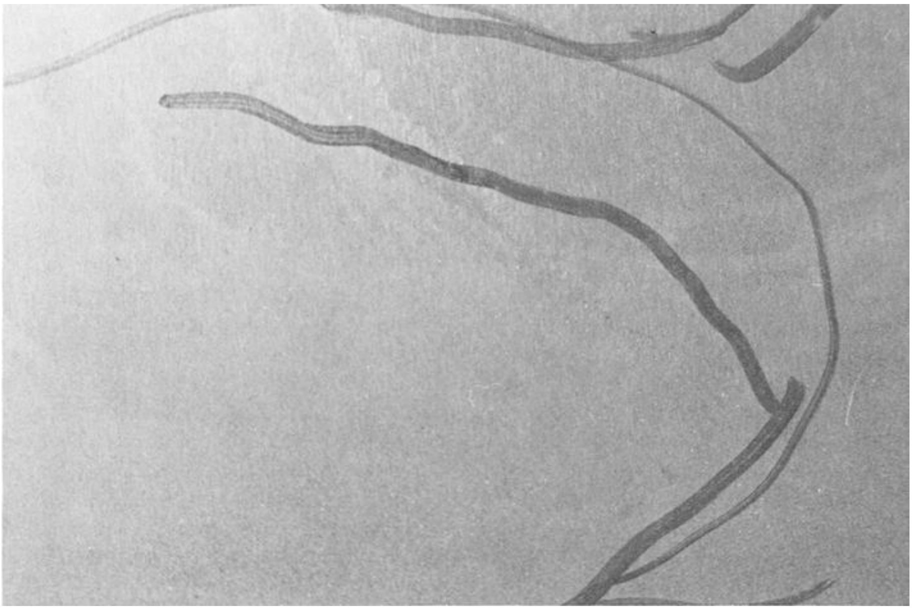

FIG. 1—*Ninhydrin-treated sample of galvanized metal in room light.*

FIG. 2—*Latent fingerprint on a sample from Fig. 1, developed by dye laser. This black-and-white print was made from a color slide. The several reproduction steps leading from original slide to printed page cause substantial loss of detail.*

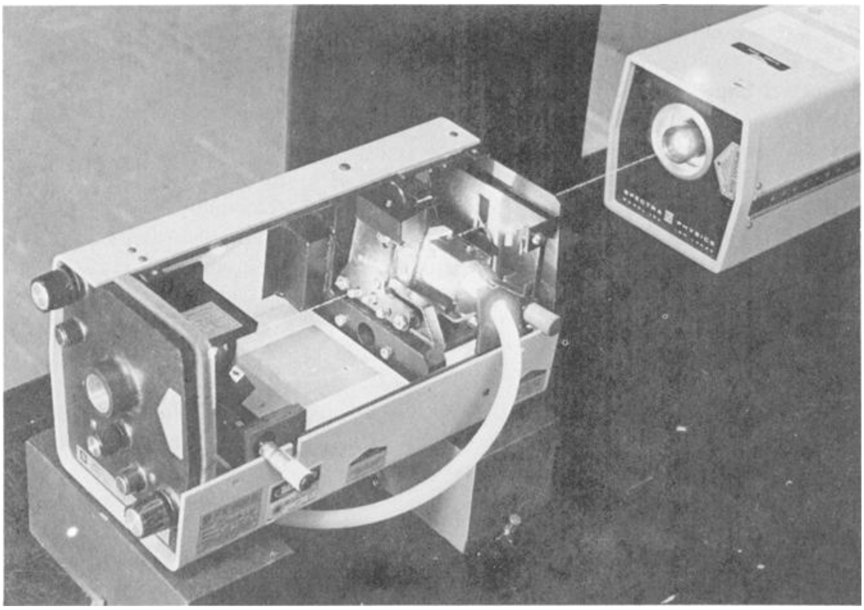

FIG. 3—*Argon laser (Spectra Physics Model 164-05, partly shown, right) and dye laser (Spectra Physics Model 375, left) system in operation.*

over one or two days but did not develop further with time. On a number of test surfaces, some paper, some glass, and many metal, we detected ridge detail under the laser when no prints at all were found in room light. Our overall success was gratifying with paper and metals, somewhat less so with glass and plastics. We note that photographic detectability can be superior to visual detectability because a substantial portion of the fluorescence occurs in the near-infrared region and because of the low sensitivity of the eye to red light. As is also the case in laser detection of latent fingerprints via their inherent luminescence, prolonged laser exposure leads to fluorescence degradation, even though the ninhydrin reaction compound that gives rise to the observed fluorescence is reasonably stable under dye laser light. Thus, laser exposure prior to photography should be kept to a practical minimum. The dye laser/ninhydrin procedure is not useful for surfaces that display strong red and near-infrared luminescence under the dye laser light.

Discussion

Law enforcement agencies currently employing laser examination for latent fingerprint detection tend to have large argon lasers (15 to 20 W). Such lasers cost on the order of $45 000, including electrical and water-cooling installation and optical accessories. Periodic replacement (perhaps once every two years) of the argon laser plasma tube (cost, more than $10 000, thus making a service contract with the laser manufacturer worthwhile) constitutes the major operating expense. To implement the laser/ninhydrin procedure, a CW dye laser (cost, about $7000) has to be added to the system. Argon-laser-pumped CW dye lasers are not difficult to manipulate, and operating expenses are minimal.

While the full exploitation of lasers in latent fingerprint work must await optimization of dusting, staining, evaporation, and chemical treatments, exploration of new treatments (particularly for latent prints on skin), and research on latent print age determination (areas currently under study in our laboratory), we believe that the laser/ninhydrin procedure already makes a significant new contribution to latent print development. In the sequence of argon laser examination for inherent fingerprint luminescence followed by dye laser examination after ninhydrin treatment, many heretofore intractable latent fingerprints should become amenable to development. We point out that the combination of ninhydrin and laser examination can be applied to nonporous surfaces generally considered unsuitable for ninhydrin development.

We are currently initiating studies of the behavior under laser illumination of surfaces treated with a combination of ninhydrin and trypsin as well as ninhydrin followed by treatment with zinc chloride or nickel nitrate.[2] The ninhydrin/trypsin procedure is designed to improve the quality of developed latent prints, whereas the ninhydrin/metal salt method changes the color of developed marks to orange and red.

Acknowledgment

This material is based upon work supported by the National Science Foundation under Grant No. DAR-8005515.

References

[1] Dalrymple, B. E., Duff, J. M., and Menzel, E. R., "Inherent Fingerprint Luminescence—Detection by Laser," *Journal of Forensic Sciences,* Vol. 22, No. 1, Jan. 1977, pp. 106-115.

[2] Menzel, E. R. and Duff, J. M., "Laser Detection of Latent Fingerprints—Treatment with Fluorescers," *Journal of Forensic Sciences,* Vol. 24, No. 1, Jan. 1979, pp. 96-100.

[3] Thornton, J. I., "Modification of Fingerprint Powder with Coumarin 6 Laser Dye," *Journal of Forensic Sciences,* Vol. 23, No. 3, July 1978, pp. 536-538.

[4] Menzel, E. R. and Fox, K. E., "Laser Detection of Latent Fingerprints: Preparation of Fluorescent Dusting Powders and the Feasibility of a Portable System," *Journal of Forensic Sciences,* Vol. 25, No. 1, Jan. 1980, pp. 150-153.

[5] Menzel, E. R., *Fingerprint Detection with Lasers,* Marcel Dekker, New York, 1980.

[6] Menzel, E. R., "Laser Detection of Latent Fingerprints—Treatment with Phosphorescers," *Journal of Forensic Sciences,* Vol. 24, No. 3, July 1979, pp. 582-585.

[7] Almog, J. and Gabay, A., "Chemical Reagents for the Development of Latent Fingerprints. III: Visualization of Latent Fingerprints by Fluorescent Reagents in Vapor Phase," *Journal of Forensic Sciences,* Vol. 25, No. 2, April 1980, pp. 408-410.

[8] Thornton, J. I. and Cashman, P. J., "Reconstruction of Fractured Glass by Laser Beam Interferometry," *Journal of Forensic Sciences,* Vol. 24, No. 1, Jan. 1979, pp. 101-108.

[9] Gross, E., Sin-David, L., and Almog, J., "Transmitted Infrared Luminescence in Document Examination," *Journal of Forensic Sciences,* Vol. 25, No. 2, April 1980, pp. 382-385.

[10] Bresee, R. R. and Crews, P. C., "Using Small-Angle Light Scattering to Discriminate Among Single Fibers Subjected to Consumer-Like Uses," *Journal of Forensic Sciences,* Vol. 26, No. 1, Jan. 1981, pp. 51-57.

[11] Dalrymple, B. E., "Case Analysis of Fingerprint Detection by Laser," *Journal of Forensic Sciences,* Vol. 24, No. 3, July 1979, pp. 586-590.

Address requests for reprints or additional information to
E. Roland Menzel, Ph.D.
Physics Department
Texas Tech University
Lubbock, TX 79409

[2]We are indebted to Robert Hazen (FBI Academy, Quantico, VA) and David Grieve (Washington State Patrol, Olympia, WA) for bringing the ninhydrin/trypsin and ninhydrin/metal salt procedures, respectively, to our attention.