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Laser Detection of Latent Fingerprints: Ninhydrin Followed by Zinc Chloride

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ABSTRACT: A pronounced improvement in detectability is observed when ninhydrin-treated latent fingerprints are sprayed with a solution of zinc chloride and subsequently subjected to argon laser examination.

KEYWORDS: criminalistics, fingerprints, lasers, ninhydrin, zinc chloride

The utility of lasers in latent fingerprint detection was first reported by one of us (Menzel) at a Michigan-Ontario Identification Association conference in London, Ont., in 1976 and published in this journal in 1977 [*1*].

Initial research in this field emphasized the detection of latent prints by means of the inherent luminescence of fingerprint residue under argon laser light. Because substrate luminescence often overwhelms the weak inherent luminescence of fingerprints, a number of treatments that are useful in such instances when combined with laser examination were soon investigated. They include dusting with fluorescent or phosphorescent powders [*2-6*], staining with solutions of fluorescent dyes [*1,6*], vapor deposition of fluorescers [*7*], and treatments with chemicals that react with fingerprint residue to form luminescent products detectable by argon laser [*2,6*]. Table 1 presents a list of compounds useful for such procedures.

At present, law enforcement agencies routinely use lasers to detect latent prints only by inherent luminescence, primarily because sufficient optimization studies have not yet been carried out to determine which of the by now large number of options is best suited to a particular instance. While some optimization studies have been performed [*8-10*], more work is needed to bring the above methods into routine use.

In a recent paper, we reported the laser examination of ninhydrin-treated latent prints [*11*]. This combination, although it entails the addition of a dye laser to the argon laser, is attractive since the ninhydrin method is sensitive and already well established: optimization work is not required. We found that prints that do not develop sufficiently well to be discernible in the usual way, that is, by their purple-blue ridge detail, can be brought out under dye laser light. Curiously, however, latent prints developed sufficiently by ninhydrin to be seen in room light did not generally respond to laser examination. We found that the combination of ninhydrin treatment and dye laser examination can be successful on non-

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TABLE 1—*Chemicals useful for laser detection of latent fingerprints* [6-8].

Blending of Luminescent Dusting Powders and Staining	Vapor Deposition	Chemical Treatments
Acridine yellow	Anthracene	Alizarin
Acridine orange	Anthranilic acid	Alizarin red S
Coumarin 6	Antimony trichloride	Alloxan
Crystal violet	*p,p'*-Dichlorodiphenylmethyl carbinol	Dansyl chloride
p,p'-Dichlorodiphenylmethyl carbinol	Rhodamine B	Eosin
3,3'-Diethyloxadicarbocyanine iodide	Rhodamine 6G	Eosin B
3,3'-Diethylthiatricarbocyanine iodide	Triphenylcarbinol	Eosin Y
Merocyanine 540		Fluorescamine
Nile blue perchlorate		Hydrindantin
Rhodamine B		4-Chloro-7-nitrobenzo-2-oxa-1,3-diazole chloride
Rhodamine 6G		Ninhydrin
		o-Phthalaldehyde
		p-Dimethylaminobenzaldehyde
		p-Dimethylaminocinnamaldehyde
		Schiff's reagent

porous surfaces (such as metals) that are generally considered unsuitable for ninhydrin development.

In this paper, we report on the combination of laser examination and modified ninhydrin treatments. The two-fold motivation for this work was to improve the sensitivity of the method and to explore modifications that would allow use of an argon laser alone, eliminating the necessity of an additional dye laser.

Experimental Procedure

We have studied two modified ninhydrin treatments:

(a) combination of ninhydrin and trypsin, and
(b) ninhydrin treatment followed by spraying with solutions of certain metal salts.

In the former modification,[2] the trypsin (a proteolytic enzyme) serves the function of cleaving proteins and peptides to small amino acid chains for improved development. In the latter,[3] the metal salts serve to change the color of developed prints to red or orange.

Ninhydrin and Trypsin

Samples were treated by either spraying with a methanol solution containing both ninhydrin and trypsin, or spraying first with a water solution of trypsin and then with a methanol solution of ninhydrin. The developments were compared visually with those of samples sprayed with methanol solutions of ninhydrin alone. Under room light inspection, the samples sprayed first with trypsin and then with ninhydrin showed a somewhat better development than those treated either by the combined solution or ninhydrin alone. Results under dye laser examination showed essentially the same features reported earlier [*11*], but no dramatically improved detectability was found.

[2]We are indebted to R. J. Hazen of the FBI Academy in Quantico, VA, for bringing this method to our attention.

[3]We are indebted to D. L. Grieve of the Washington State Patrol in Olympia, WA, for bringing this method, which was developed in the United Kingdom, to our attention.

Ninhydrin and Metal Salts

The color of ninhydrin-developed fingerprints changes to red, orange, and red when such prints are sprayed with solutions of nickel nitrate, zinc chloride, and cadmium nitrate, respectively. We have subjected prints treated in this way to argon laser examination. Because of the health hazard associated with cadmium, we confined our studies to nickel nitrate and zinc chloride.

Fingerprints were deposited on white paper, black plastic (trash bag), and a black plastic photographic film container. Some prints were developed by inherent fingerprint luminescence on argon laser examination. The samples were left in open air for two days before treatment with ninhydrin (formulated as in Table 2). The ninhydrin-treated samples were left for two additional days and then inspected by room light and under a laser. In room light, white paper samples showed developed prints by their characteristic purple-blue color, whereas the plastic samples showed no discernible development. Examination under dye laser light of 580-nm wavelength revealed no additional prints. Paper samples were then sprayed with a solution of zinc chloride, formulated as in Table 2, and nickel nitrate, using a similar recipe. The salt treatments produced immediate color changes of developed marks to orange and red, respectively, with occasional slight loss of detail.

Under argon laser illumination (3 W, all lines) and inspection through the usual argon laser safety goggles, the nickel nitrate-treated samples showed no appreciable luminescence. The zinc chloride-treated samples, however, showed a very strong luminescence; a number of prints were developed that had not been discerned at all before. Figures 1 and 2 show a print in this category. In contrast to the case of dye laser/ninhydrin development [*11*], prints developed sufficiently to be seen in room light before and after zinc chloride treatment often showed significantly improved contrast under argon laser examination. To determine what laser light color would be best suited for examination, we measured the absorption spectrum of a solution containing leucine (an amino acid) that had reacted with ninhydrin and zinc chloride, using a Cary 14 absorption spectrophotometer. The absorption spectrum, shown in Fig. 3, shows that one of the major argon laser lines (488 nm) is excellently suited for illumination. We also measured the luminescence spectrum of this solution, shown in Fig. 3, using argon laser illumination, a 0.3-m scanning monochromator, and photon-counting instrumentation. The luminescence is broad, ranging from green to red. Thus, filtering in cases where background luminescence is present should not be difficult. In our previous work [*11*] on dye laser examination of ninhydrin-treated prints, the observed luminescence occurred in the red and near-infrared, and good photographic contrast often required the used of color infrared film. Here, on the other hand, black-and-white Tri-X® Pan film generally was quite adequate.

In view of our success with ninhydrin- and zinc chloride-treated prints on paper, the plastic samples mentioned above were also treated with zinc chloride. Though no print development was apparent on inspection in room light after zinc chloride treatment, a number

TABLE 2—*Ninhydrin and zinc chloride solutions used for sample treatment.*

Solution	Ingredients	Amount	Procedure
Ninhydrin	ninhydrin	500 mg	mix first three ingredients and then add the fourth
	glacial acetic acid	1 mL	
	ethyl alcohol	3 mL	
	Freon TF®	95 mL	
Zinc chloride	zinc chloride	3 g	mix first three ingredients and then add the fourth
	ethyl alcohol	25 mL	
	acetic acid	5 mL	
	Freon TF®	70 mL	

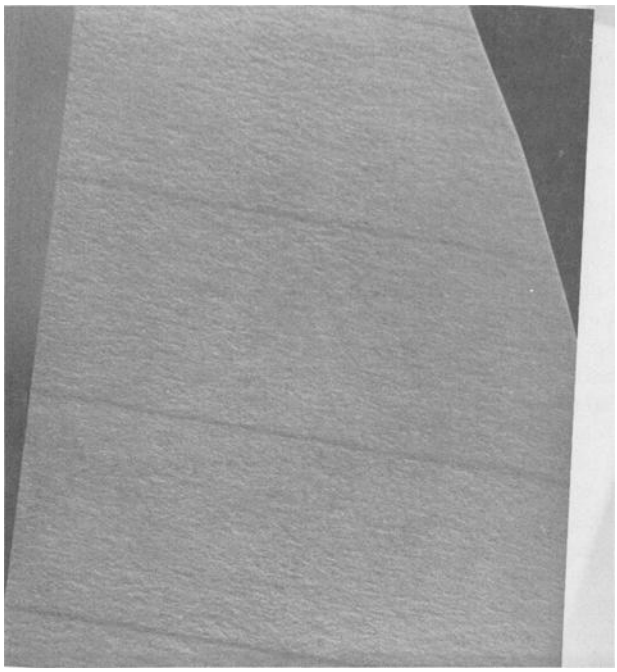

FIG. 1—*Room light photograph of paper treated with ninhydrin followed by zinc chloride*

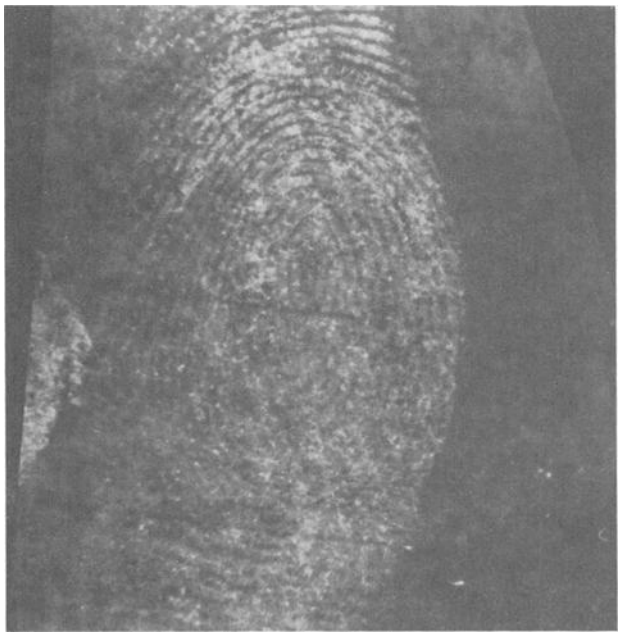

FIG. 2—*Latent print on sample in Fig. 1 developed by argon laser.*

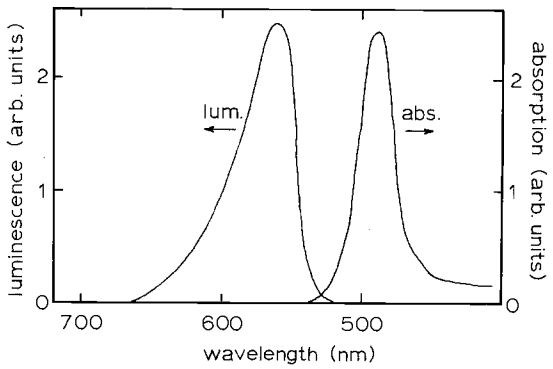

FIG. 3—*Room temperature absorption and luminescence (prefiltered with an argon laser safety filter [Fisher 11-409-50A]) spectra of a solution of leucine reacted with ninhydrin and zinc chloride.*

FIG. 4—*Latent print on black plastic photographic film container, treated with ninhydrin and zinc chloride and developed by argon laser.*

of prints with good ridge detail emerged under the argon laser. One of these is shown in Fig. 4.

Discussion

Laser detection of latent fingerprints was originally conceived as a nondestructive method for the development of latent prints that would not interfere with conventional procedures. Modified approaches to laser development, including dusting with fluorescent powders, staining with fluorescent dye by either solution or vapor procedures, and chemical treatments leading to fluorescent reaction products, were researched because surfaces often luminesce strongly under the laser, overwhelming inherent fingerprint luminescence. Unfortunately, such procedures may interfere with conventional methods in that they force a

choice as to which procedure is to be used. Though laser detection of latent prints is rapidly gaining acceptance, latent print examiners will likely retain a preference for well-established procedures until extensive optimization and comparison studies are completed.

The modified ninhydrin procedure described in this paper does not suffer from this drawback. We envision the treatment of articles of evidence (perhaps after examination under laser for inherent fingerprint luminescence) by ninhydrin (the workhorse of latent print examination) in the normal manner. Once this examination is complete, dye laser examination can follow (if a dye laser is on hand), and finally, treatment with zinc chloride and argon laser examination can be used. Of the chemical treatments we have investigated to date for utility when combined with laser examination, the ninhydrin-zinc chloride procedure has given us by far the most promising results. We emphasize that this procedure will frequently enhance the ridge detail of prints developed by ninhydrin in the conventional fashion and that prints not developed in the conventional manner will often emerge after zinc chloride treatment and laser examination. Finally, this approach can be successful on nonporous surfaces not normally considered suitable for the ninhydrin treatment. We envision the modified ninhydrin approach to such surfaces in cases where latent prints are too old to respond to dusting.

Acknowledgments

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