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Laser Detection of Latent Fingerprints: Treatment with Glue Containing Cyanoacrylate Ester

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ABSTRACT: It has previously been shown that fuming with glue containing cyanoacrylate ester can be valuable in the development of latent fingerprints. Glue-treated fingerprints can provide improved detail via fluorescence under ultraviolet and blue-green argon-ion laser illumination. In addition, glue treatment can be effectively combined with dusting using fluorescent powder, staining using fluorescent dye, and the ninhydrin/zinc chloride method, together with laser examination.

KEYWORDS: criminalistics, fingerprints, lasers, glue, cyanoacrylate ester, rhodamine 6G, ninhydrin, zinc chloride

The utilization of lasers for the development of latent fingerprints was first reported in the forensic science literature in 1977 [*1*]. Early research focused on development of latent fingerprints via their inherent fluorescence under argon laser illumination. Since then, a number of procedures falling into three categories, namely dusting with luminescent powders, staining with fluorescent dyes, and treatment with chemicals that react with fingerprint material to form fluorescent reaction products, have been devised [*2-10*] to permit laser detection of latent prints in instances in which detection by inherent fluorescence fails. By now, the use of lasers in latent fingerprint development has been demonstrated in several case studies [*11-13*] and a growing number of law enforcement agencies have acquired laser for latent print work.

Our recent activity in the field has focused on *combining* certain conventional procedures with laser development. Evidence examination in a law enforcement agency not equipped with an argon laser can be carried out with such procedures without detriment to subsequent examination by a laser-equipped laboratory to which the evidence may be sent. Laser examination for inherent fingerprint fluorescence should be carried out before any other procedure, if possible. If this is not feasible, however, then the evidence can be dusted without loss to subsequent laser examination, provided that an appropriate fluorescent powder is used. A number of such powders are already commercially available. Fluorescent dusting powders can easily be homemade as well [*2,7*]. We fully expect that in the near future a range of commercial powders will specifically be designed for use with argon lasers while, at

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the same time, retaining all the features one expects from a conventional powder. The ninhydrin method can also be applied without deleterious effect on subsequent laser examination [*9*]. The ninhydrin treatment is simply followed by spraying with a solution of zinc chloride before laser examination. A mixture of methanol and 1,1,2-trichloro-1,2,2-trifluoroethane (freon), in approximate ratio 1:4, constitutes an effective carrier for the zinc chloride (as well as the ninhydrin). In this paper, we report on a third, and very promising, combination of a conventional method and laser examination.

Cyanoacrylate Ester and Laser Examination

Recent articles have described a method of latent fingerprint development that involves the use of glues containing cyanoacrylate ester [*14,15*]. Such glues come under a variety of trade names, such as Super Glue®, Wonder Bond®, and so forth. Articles to be examined are placed into a closed container together with a few drops of the glue. The cyanoacrylate ester of the glue evaporates and polymerizes on the ridges of latent fingerprints to form a white product via which the prints become visible. The method is quite effective for smooth nonwhite surfaces, such as metals, glass, plastics, and so on. We find that thus developed prints fluoresce under both ultraviolet and blue-green argon-ion laser illumination. Under ultraviolet argon laser light, the fluorescence is generally greenish blue. Under blue-green argon-ion laser illumination, the fluorescence is yellowish green. Since the fluorescences are not particularly intense, laser examination is not useful on articles such as white paper, which themselves fluoresce strongly under ultraviolet and blue-green laser light. However, metals in general, glass, and many plastics can be effectively laser examined after glue treatment. The choice of ultraviolet versus blue-green illumination is simply a matter of the fluorescence of the surface holding the latent print. Figure 1 shows a fingerprint on a piece of blued steel developed by glue treatment. A room light photograph is shown in Fig. 1*a*. The same print developed by ultraviolet argon laser illumination is seen in Fig. 1*b*, and under blue-green argon-ion laser light in Fig. 1*c*. The most noteworthy fingerprint feature is the delta region which shows virtually no detail in room light but good detail under the laser, clearly demonstrating that laser examination of glue-treated prints can yield added sensitivity. All glue-treated articles discussed in this paper were exposed to the glue for about one day without accelerant [*15*].

As with any new fingerprint development method, the question of order of examination procedures arises. We have investigated sequential examinations involving glue treatment, inherent fluorescence, dusting, dye staining, and ninhydrin/zinc chloride treatment. Test prints were deposited on test surfaces under as nearly identical conditions as possible by several donors and were left in ambient conditions for several days before any examination or treatment. Figure 2 compares a print on aluminum foil developed first by inherent fluorescence (*a*) and then by glue treatment, both times under blue-green argon-ion laser light. The print of Fig. 2*b* showed appreciably higher fluorescence intensity than that of Fig. 2*a*. Figure 3*a* shows a print on aluminum foil dusted with a magnetic powder (Sirchie FMP-01) blended with the fluorescent dye rhodamine 6G [*7*] and developed by blue-green argon-ion laser illumination. A similar print was dusted with this powder after glue treatment and then laser-developed. This print is shown in Fig. 3*b*. The adhesion of the powder to the print was significantly reduced after glue treatment, but still sufficient to yield a fluorescence intensity comparable to that of the only dusted print. Photographs comprising Fig. 3*a* and *b* were made under equal conditions.

Figure 4 compares a print on aluminun foil developed by laser after dusting with the above powder (*a*) with the same print after subsequent glue treatment and laser examination (*b*). The two photographs were obtained under identical conditions, excepting photographic exposure time. The exposure of Fig. 4*b* was 1/4 s versus 30 s for Fig. 4*a*, demonstrating a dramatic increase in fluorescence efficiency achieved by the glue treatment following the

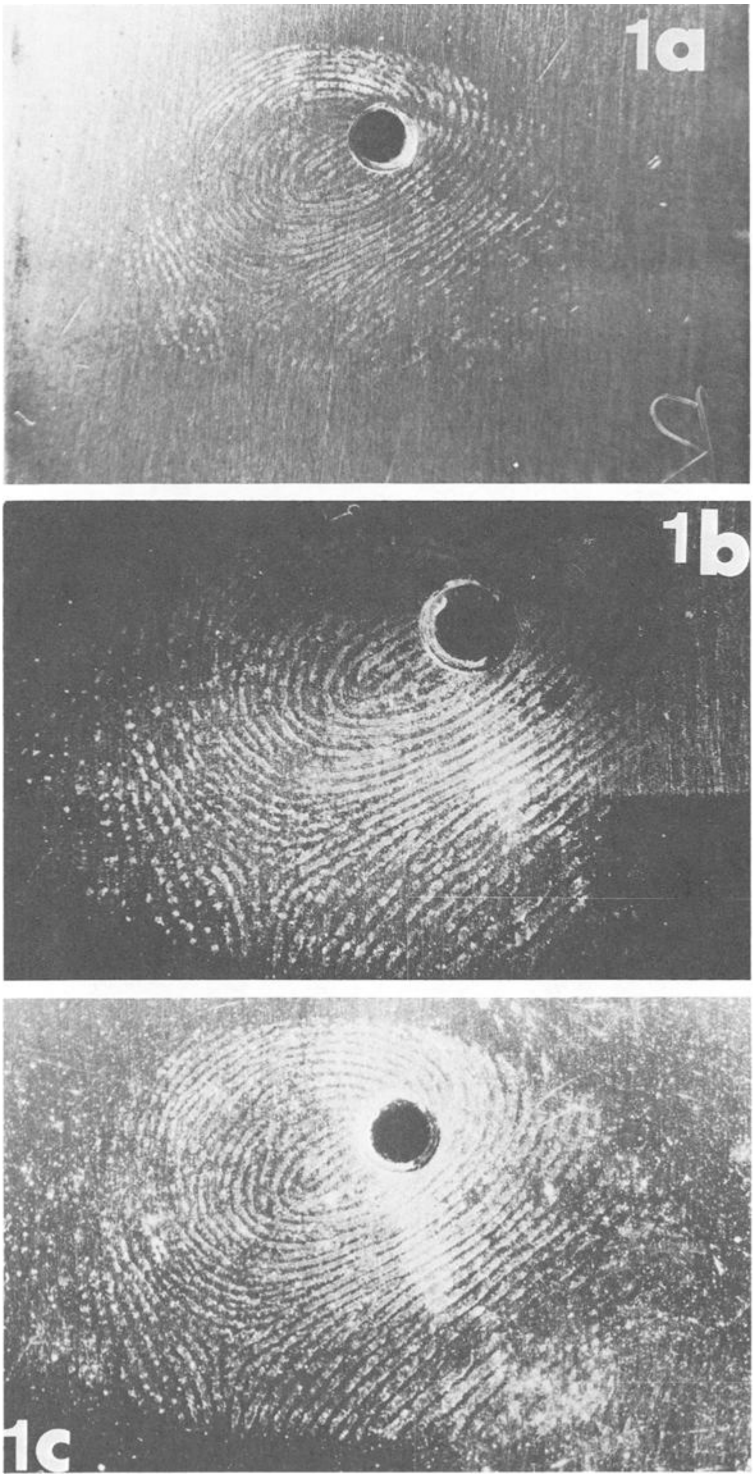

FIG. 1—*Glue-treated fingerprint on blued steel in room light* (a), *under ultraviolet argon-ion laser illumination* (b), *and under blue-green argon-ion laser illumination* (c).

FIG. 2—*Fingerprint on aluminum foil developed under blue-green argon-ion laser first by inherent fluorescence* (a) *and then by glue treatment* (b).

dusting. A substantial increase in fluorescence was also found on paper currency dusted with the blended powder and subsequently treated with glue. We speculate that the rhodamine 6G is incorporated into the polymer in a manner akin to a solid solution, which increases the dye's fluorescence quantum efficiency. Increases in solution versus powder fluorescence are quite common in organic dyes. That the rhodamine has an affinity for glue-treated prints is readily seen if glue-treated prints are stained evaporatively [*6*] or with a methanol solution [*7*] of rhodamine 6G.

Figure 5 compares two glue-treated prints (*a*, room light) with the same prints after subsequent dye staining (*b*, under laser). To provide an appreciation of the fluorescence strength (Fig. 5*b*), note that the fluorescence of the prints was easily observable (through the appropriate laser safety goggles) in a darkened room at a distance of some 6 m from the

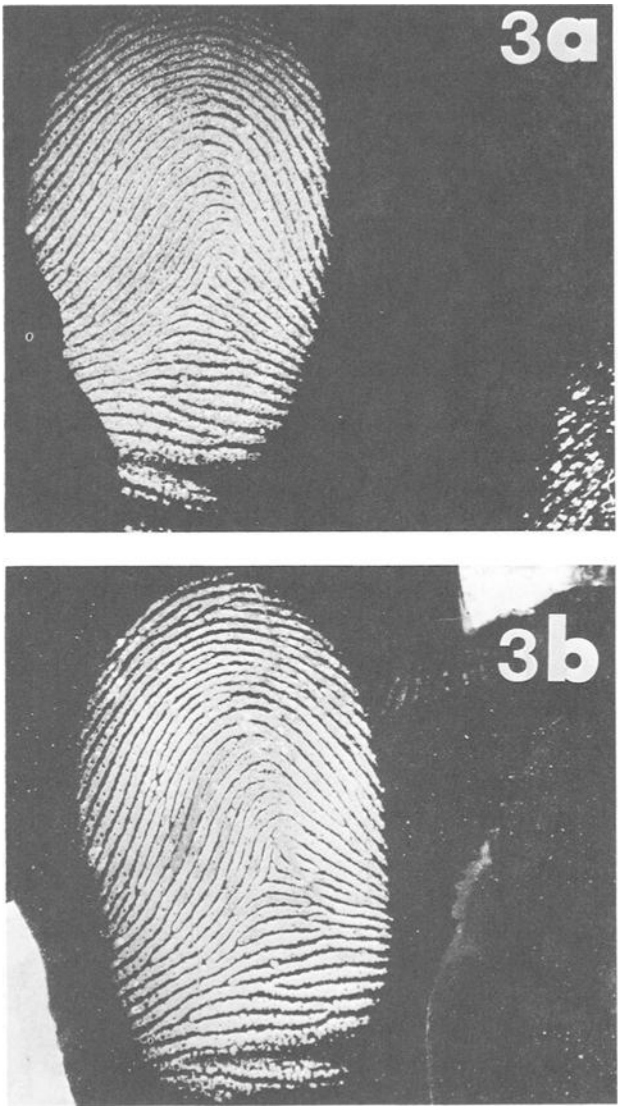

FIG. 3—*Fingerprints on aluminum foil developed under laser by dusting* (a) *and dusting after glue treatment* (b). *Photographs made under equal conditions.*

prints that were illuminated by 3 W of blue-green argon-ion laser light, with the beam expanded to cover an area of about 100 cm^2. The solution dye staining (left print in Fig. 5) amounted to simply immersing the article (aluminum foil) in a methanol solution of the dye for a few seconds and then washing off excess dye with methanol. Because the glue treatment renders latent prints resistant to solvents such as methanol, no particular delicacy was needed in the solution staining. Prints not treated with glue need to be solution stained very delicately, particularly when fresh, if they are not to wash off the surface under examination. The vapor staining (right print in Fig. 5) consisted of heating the dye in a beaker on a hot plate and holding the article (glass) over the beaker for a few seconds.

To further explore the potential use of combining glue treatment and dye staining, a fresh

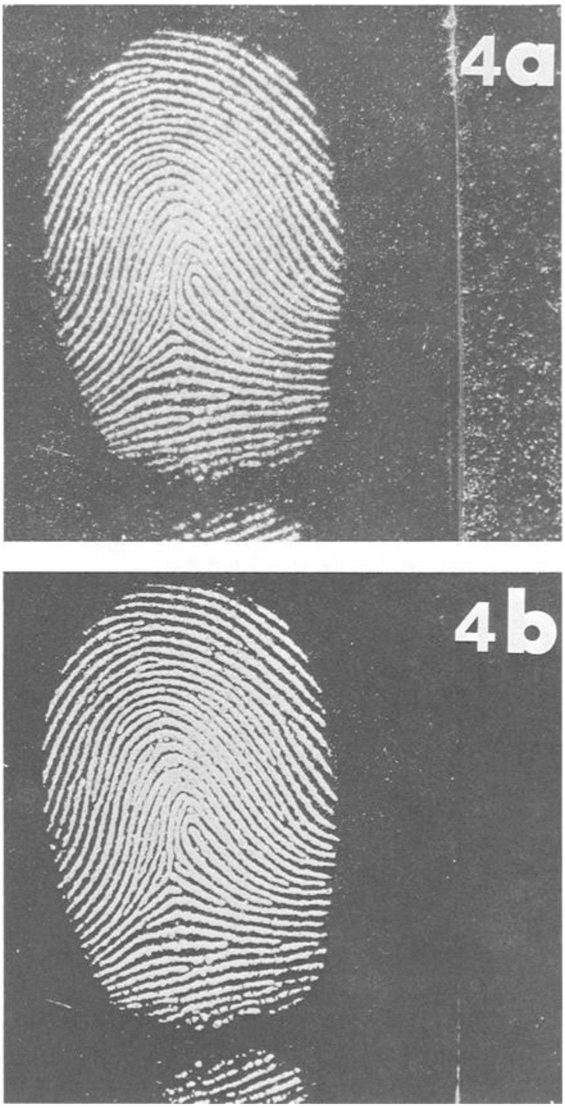

FIG. 4—*Fingerprint on aluminum foil developed under laser first by dusting* (a) *and again after subsequent glue treatment* (b). *Photographs made under equal conditions, excepting exposure time, 30 s for* a *and* 1/4 *s for* b.

print on fine-weave synthetic cloth (light blue) was solution stained with rhodamine 6G after glue treatment. Figure 6 shows the print before (*a*, room light) and after staining (*b*, under laser). Again, the dye fluorescence was quite intense and significantly improved the observable ridge detail.

Although ninhydrin is generally not used on smooth surfaces, we have previously found that the ninhydrin/zinc chloride/laser method can be effective on such surfaces if the ninhydrin and zinc chloride are sprayed delicately onto the surfaces [*9*]. Figure 7*a* shows a ninhydrin/zinc chloride/laser developed print on aluminum foil. The detail is spotty (washing out by the two-step spraying with methanol/freon solutions). Figure 7*b* shows a

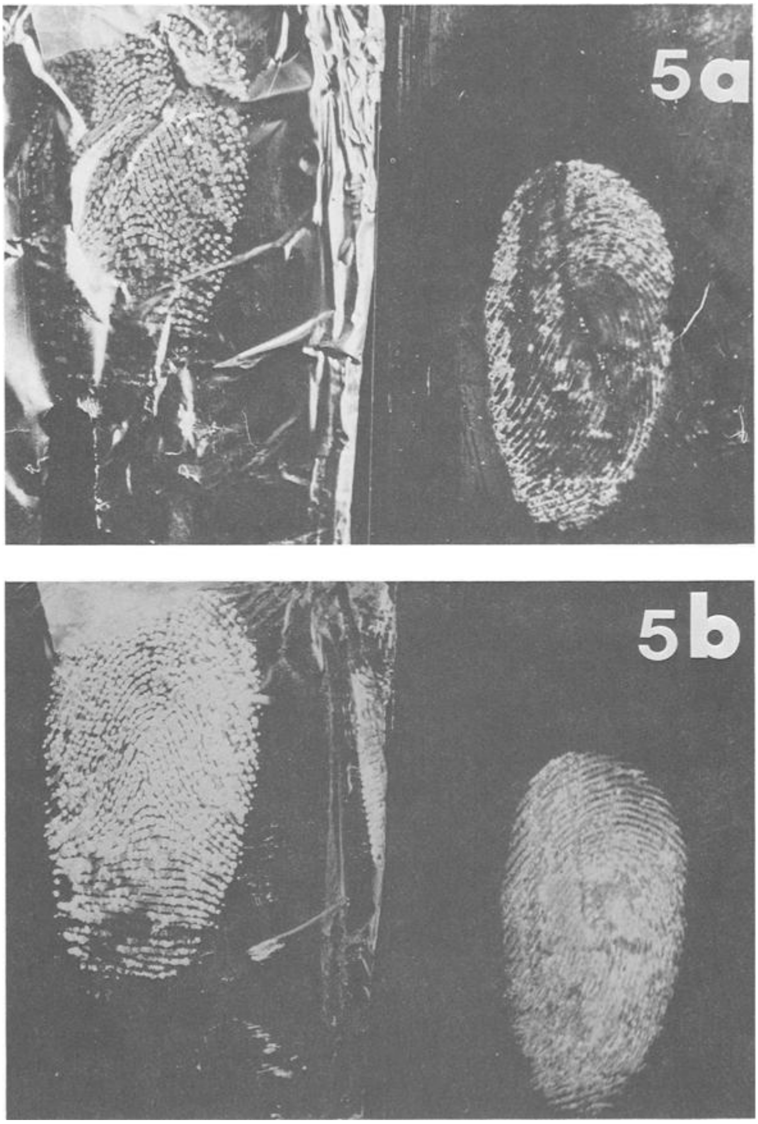

FIG. 5—*Two latent prints developed first in room light by glue treatment* (a) *and then under laser after dye staining* (b). *The left print in each photograph, on aluminum foil, was stained with a solution of rhodamine 6G. The right print in each photograph, on glass, was evaporatively stained with this dye.*

similar print on aluminum foil treated with glue before ninhydrin/zinc chloride application and laser examination. The effect of the ninhydrin/zinc chloride step following glue treatment was clearly observable by the fluorescence color change from yellowish green to the characteristic orange of the ninhydrin/zinc chloride procedure. We found that the incubation times for the ninhydrin and zinc chloride reactions were longer for glue-treated prints than for untreated ones, presumably because the glue-induced polymerization inhibits penetration of the ninhydrin and zinc chloride into the bulk of the fingerprint deposit. The most notable feature seen on comparison of Fig. 7*a* and *b*, however, is the far sharper detail in the latter. As with the earlier described dye staining, the glue treatment stabilizes the la-

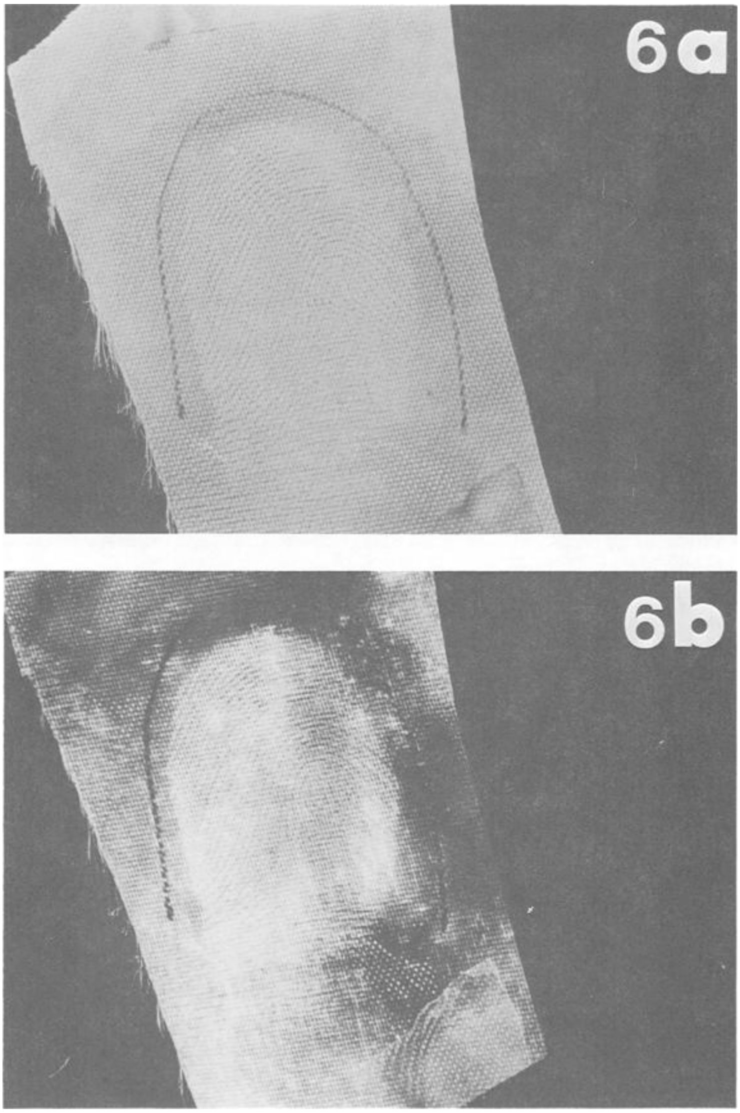

FIG. 6—*Fingerprint on fine-weave light blue synthetic cloth developed first in room light by glue treatment* (a) *and then under laser after rhodamine 6G solution staining* (b).

tent print, making it more suitable to subsequent spraying with the ninhydrin and zinc chloride solutions.

To explore the potential benefit of heating, samples treated with glue and then with ninhydrin were heated with a steam iron. This is a procedure widely used by latent print examiners to expedite ninhydrin development. Subsequently, these samples were treated with zinc chloride, again heated with the iron, and then examined under laser. The results were compared with samples similarly treated except for the absence of the initial glue step, and with samples that were not heated. Figure 8 compares a glue/ninhydrin/zinc chloride treated print on aluminum foil in absence of heating (*a*) with a similar print subjected to

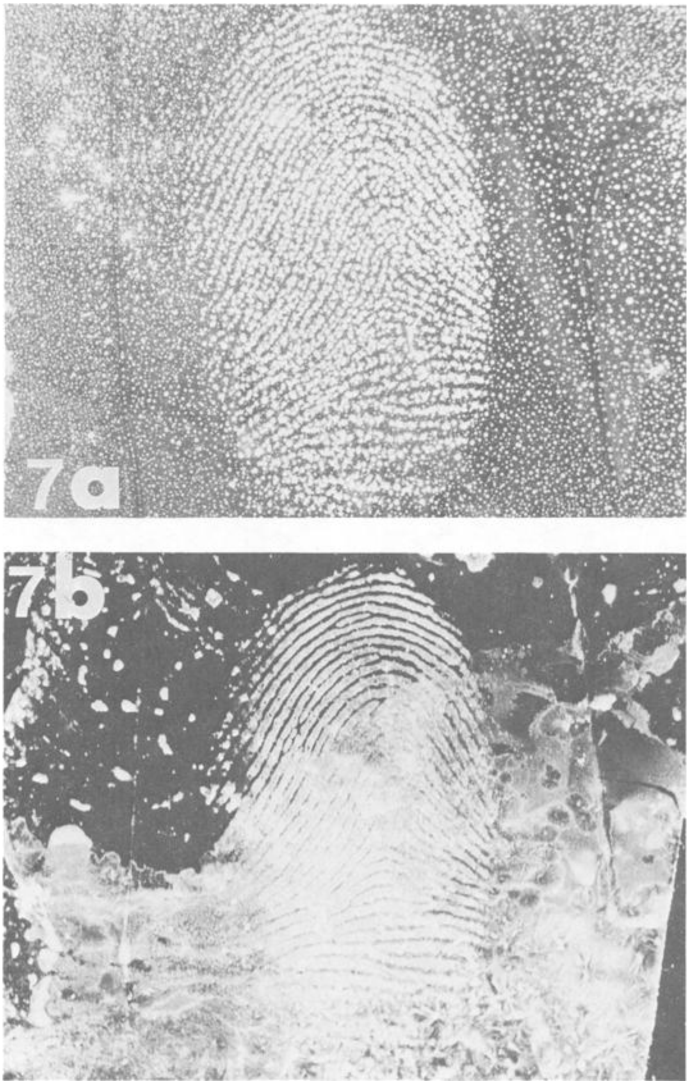

FIG. 7—*Fingerprint on aluminum foil developed under laser after ninhydrin/zinc chloride treatment* (a) *and similar print on aluminum foil developed under laser by ninhydrin/zinc chloride treatment subsequent to glue treatment* (b).

heating (*b*). The photographic exposure of the print in Fig. 8*a* was three times that for 8*b*, indicating that the heating improves detectability. It is also worth noting that the background in Fig. 8*b* is substantially lower than in 8*a*. Prior to zinc chloride treatment, the print of Fig. 8*a* was left to incubate for 24 h following ninhydrin treatment. Following zinc chloride treatment, the print was left to incubate for several hours before laser examination. We find that longer incubation times generally do not produce improved results. No incubation times were taken after the ninhydrin and zinc chloride steps for the print in Fig. 8*b*. Comparison between dry heating and heating in presence of moisture (dry ironing versus steam ironing) following ninhydrin treatment produced generally comparable results. Dry heating after the zinc chloride step was found to be preferrable over steam heating because

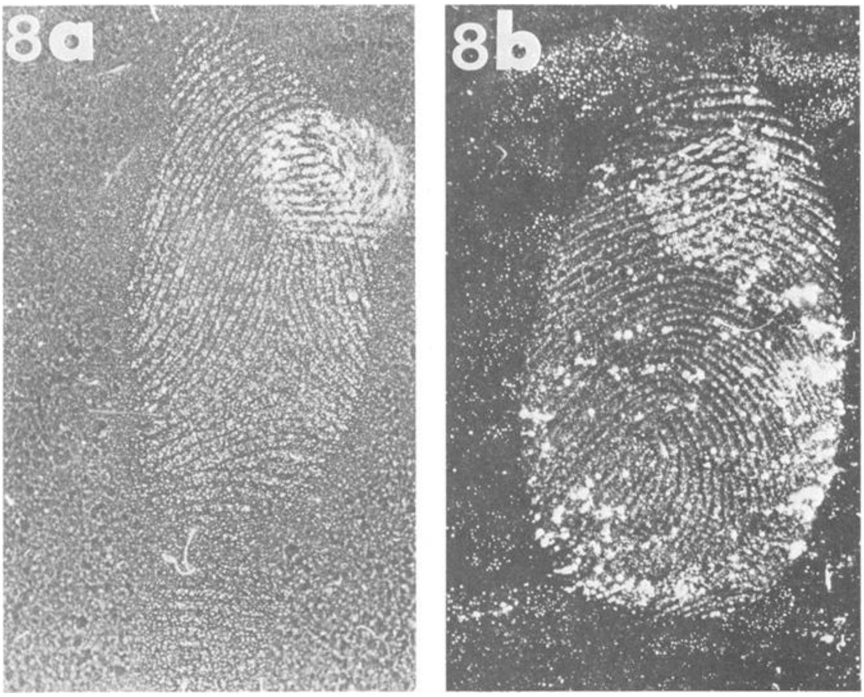

FIG. 8—*Fingerprint on aluminum foil developed under laser by glue/ninhydrin/zinc chloride without heating* (a) *and print developed similarly, but with heating* (b). *Photographs taken under equal conditions excepting exposure times, 3 s for* a *and 1 s for* b.

the latter tended to cause higher background fluorescence and washing out of ridge detail, particularly on porous surfaces such as paper.

Whereas the heating was generally beneficial to prints on aluminum foil, heating of prints on paper did not yield additional sensitivity, but, of course, made for speedier examination. Finally, the effects of heating were investigated for prints on paper and aluminum foil in absence of the glue step. For prints on paper treated with ninhydrin and zinc chloride, heating produced no additional sensitivity. For prints on aluminum foil, heating tended to destroy the prints. Fingerprint quality on paper was found to be generally unaffected by glue treatment before ninhydrin/zinc chloride application.

Conclusion

The above described investigations indicate that glue treatment of latent prints can on its own be combined effectively with laser examination. In addition, combination of glue treatment with other procedures (dusting, staining, and ninhydrin/zinc chloride) can add substantially to latent print detectability. Within the framework of laser detection of latent fingerprints, glue treatment following dusting and preceeding ninhydrin/zinc chloride would appear to be the best examination sequence. Dye staining, preferrably evaporative for fresh prints and by solution for old prints, is at present not widely used in fingerprint laboratories equipped with lasers, but shows some promise for fingerprint development on skin in the evaporative mode [*16*]. An additional measure of the potential value of dye staining is indicated by the following brief description of a recent case examination carried out in our laboratory. A smoke bomb, which had been dusted with conventional powder, was next laser examined in the Potter County Sheriff's Department (Amarillo, TX) by inherent fluorescence, dusting, evaporative staining, and ninhydrin/zinc chloride. After all procedures had failed, the bomb was brought to our laboratory where solution staining and laser examination produced two prints. This, together with our results on the combination with glue treatment, suggests that dye staining may become an additional valuable procedure for laser development of latent prints.

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