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Basic Fuchsin—A Guide to a One-Step Processing Technique for Black Electrical Tape

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ABSTRACT: Detection of fingerprint evidence on black electrical tape has often been a frustrating experience for many examiners because of the very nature of the substrate.

The tape, which is frequently found on numerous crime-related exhibits, particularly weapons, requires a number of steps to render any evidence visible, including separate processing techniques for each of the surfaces.

Basic fuchsin (rosaniline chloride) is a fluorescent reagent which provides a "one-step" alternate processing technique.

Fingerprints of different ages and from a variety of donors were processed and the results, as well as the comparison of this process with the established techniques of gentian violet (or crystal violet) and cyanoacrylate/rhodamine 6G, are discussed.

KEYWORDS: forensic science, basic fuchsin, rosaniline chloride, black electrical tape, lasers, fluorescent dye, gentian violet

Gentian violet has been the processing technique of choice in the development of fingerprints on all types of adhesive tapes for a number of years.

It is an effective staining agent that attaches itself to the dead skin cells (squamae) and likely some subaceous materials deposited on the adhesive surface of tape upon contact with friction skin [*1–4*].

The nature of most adhesive tapes and the color of gentian violet provide adequate contrast for visualization of developed evidence. However, black electrical tape is not so amenable [*2*].

In order to visualize any developed evidence, it must be examined with oblique lighting or by using fixed photographic paper to record the evidence by way of a "transfer-method" [*1,4*].

The resultant laterally reversed impressions must then be photographically corrected.

In most cases, further examination of the smooth surface of tape is required, necessitating the use of additional processing techniques—usually cyanoacrylate ester fuming/rhodamine 6G fluorescent laser dye [*4,6,7*].

Mikephor BS, an ultraviolet excited fluorescent staining technique [*5*] was tested on black electrical tape with less than encouraging results.

Menzel has reported [*6,7*] basic fuchsin is the subject of ongoing studies as an alter-

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native to gentian violet because of its chemical similarities and likewise adherence properties.

Basic fuchsin (rosanaline chloride) is an industrially used organic dye that is available from most chemical manufacturers in the form of crystals or as a dry powder. It is a fluorescent staining technique used in a similar manner to that of gentian violet. However, the visualization of evidence is conducted under an alternate light source (such as, Argon-ion laser or Lumalite™).

Case Report

My interest in the fuchsin process was initiated as a result of a discussion during an actual case exhibit examination.

A 9 mm handgun was received for examination wrapped in a piece of garbage bag and completely bound with black electrical tape. Prior to receipt, the weapon had been buried (hidden) for an unspecified period of time.

The tape was removed and processed with basic fuchsin. My understanding of the process at the time was that the reagent would stain any evidence on the adhesive surface of tape in much the same way as gentian violet, with the only differential being the manner of visualization.

The laser examination of the adhesive surface yielded negative results, but the subsequent chance examination of the smooth surface revealed two partial impressions on separate pieces of tape.

(The case was concluded before the impressions were ever identified).

Test 1—A Fuchsin Reactor—Tests and Results

The initial tests were designed to identify a single fuchsin "reactor." A number of tape samples bearing donor prints consisting of deposits from some common household lubricants,[2] and "naturally occurring" latent deposits were processed in solutions of Fuchsin/Water and Fuchsin/Methanol (Fuchsin product #220-12, E.M. Diagnostic Systems). Donors consisted of male and female persons aged 24 to 48 years. NOTE: Experiments on alternate fuchsin "carrying agents" were conducted in tandem in each series of tests throughout this research to determine if a less-hazardous solution (water) would be as effective as methanol. This was accomplished by processing both halves of each sample of tape in separate solutions.

The results of the subsequent laser examination revealed fingerprint development had occurred (to varying degrees) on almost all surfaces of every one of the samples tested, with a relatively even distribution of results given to both solutions. The results indicate the probability that the fuchsin process relies upon a "combination" of key reactors. I welcome further comments regarding this.

Method—Procedure for Use

The process calls for the addition of 0.02 grams of basic fuchsin per 400 mL of Methanol or distilled water, which will produce a fuchsia or deep red-colored solution. (Fuchsin crystals dissolve very quickly in methanol but take considerably longer to com-

[2]The household lubricants used were: WD40; Vaseline; Motormaster General Purpose Grease; Techspray "slic" Silicone Lubricant; "Zap-it" Light Lubricating Spray; GC Pressurized Lubricating Oil.

pletely dissolve in water and continuous stirring is recommended until dissolution is complete.)

The solution is then placed in a glass or metal tray of sufficient size dependent upon the quantity of tape to be processed. The tape is simply immersed in the solution for approximately 50 s to 1 min[3] then rinsed under running tap water and allowed to air dry. (There may be a tendency for the tape to curl, particularly with a new batch of solution). NOTE: It should be remembered that basic fuchsin is a suspected carcinogen and therefore all necessary precautions should be observed when using this technique [*8,9*].

When processing is complete, it is recommended the solution be discarded as the shelf-life may be limited to a very short time. Once dry, the tape is examined under laser luminescence or an alternate light source with an orange filter (such as, 11-409-50A). The resultant impressions will fluoresce at the approximate wavelength of Rhodamine 6G [*10*] with an absorption maximum of about 500 nm (yellow/orange) but with noticeably weaker fluorescence.

Developed impressions resulting from the presence of foreign materials on the friction skin at time of deposition provided the greater contrast for visualization on both surfaces of the tape. However, weak fluorescence was a problem, particularly with naturally occurring latent deposits. Notwithstanding this, a close and diligent examination of these impressions revealed good to excellent clarity of ridge detail.

An obvious but important factor to remember when using the laser or alternate light source in such close proximity to the tape (or exhibit), is the emission of heat, which can and will destroy evidence very easily.

To prevent potential damage to the evidence and exhibit, the tape was placed onto a clear piece of glass and examined "through" the glass. Photography of evidence would be conducted in the same manner as no problems with "glare" were encountered.

The stability of the evidence was in most cases unaffected upon contact with the glass. The exception was the "Motormaster Grease" impressions which were very fragile. (If in doubt, test a small area first).

The photographic process is similar to that of cyanoacrylate/R6G developed prints with the exception being a slightly longer exposure time in some cases.

Test 2—Comparing Other Fuchsin Products

Excluding the initial tests on fuchsin "reactors" that dealt only with product #220-12 (E.M. Diagnostic Systems), each of the following types of basic fuchsin produced by their respective manufacturers were tested in all subsequent series of experiments throughout tests no. 2 and no. 3 in an attempt to determine the most effective fuchsin product available: Product #86-202-9; 85-734-3; 86-108-1—Aldrich Chemical Corporation; Product #220-12—E.M. Diagnostics Systems Inc.; Product #B34032-26—BDH Chemicals; Product #R-665—Anachemia.

Upon conclusion of all tests (on naturally occurring latent impressions) product #86-202-9 (Aldrich) was found to possess the greatest fingerprint development capabilities and consequently all subsequent references to test results are confined to this product for the purposes of this article.

[3]An optimum immersion time was determined from tests on a number of tape samples bearing donor prints. Each sample was immersed in solution for a period of time ranging from 10 s to 1 min (at 10 s intervals); and 1 min to 5 min (at 1 min intervals). Prolonged immersion beyond one minute did not appear to provide any additional benefit to the development process.

TABLE 1—*Fuchsin and methanol solution.*

Piece #1(A)	Excellent impressions developed on adhesive surface. Reasonable quality impressions developed on smooth surface.
Piece #2(A)	Identifiable impressions developed on both surfaces although poorer quality impressions noted on smooth surface.
Piece #3(A)	Good quality impressions developed on both surfaces.
Piece #4(A)	Very good quality impressions developed on adhesive surface. Reasonable quality impressions noted on smooth surface.

The black electrical tape used in all tests was Super Scotch 88 Vinyl Plastic—Manufactured by 3M (#19-3954), Hutchinson, MN.

Donor prints were deposited on both surfaces of a number of pieces of tape and left undisturbed at room temperature for two days. One-half of each sample was processed in a solution of fuchsin and methanol and the remaining half processed in a solution of fuchsin and water.

Product 86-202-9 produced the results shown in Tables 1 and 2.

Evaluation

Results show identifiable evidence was developed on all but one of the surfaces of tape samples tested possessing varying degrees of quality with a relatively even distribution of results obtained from both solutions.

Test 3—Older Latent Impressions

Tests so far have been conducted on "recently deposited" latent impressions. In reality however, most developed evidence on exhibits received for examination are usually of a considerably greater age than one or two days.

The next series of tests focused on "older" latent impressions and were conducted in the same manner as all previous tests, but this time the samples bearing donor impressions were left for a period of one month. The processed samples produced the results shown in Tables 3 and 4.

Evaluation

The results demonstrated the fuchsin to be an effective process on older latent impressions with development of *identifiable* evidence (from both solutions) occurring on all but two surfaces of the samples tested.

However, it should be noted there was a significant reduction in *overall* quality of the developed evidence which would indicate that as with most other techniques, the amount of time that has passed since deposition (allowing for the loss or deterioration of con-

TABLE 2—*Fuchsin and water solution.*

Piece #1(B)	Very good quality impressions developed on both surfaces.
Piece #2(B)	Good quality impressions developed on adhesive surface. Very poor quality (not identifiable) impressions noted on smooth surface.
Piece #3(B)	Good quality impressions developed on adhesive surface. Reasonable quality impressions noted on smooth surface.
Piece #4(B)	Excellent quality impressions developed on adhesive surface. Poor, but identifiable impressions noted on smooth surface.

TABLE 3—*Fuchsin and methanol solution.*

Piece #1(A)	Good quality impressions developed on smooth surface. Negative results on adhesive surface.
Piece #2(A)	Identifiable impressions developed on both surfaces with poorer quality noted on adhesive surface.
Piece #3(A)	Identifiable impressions developed on both surfaces although very faint.
Piece #4(A)	Identifiable impressions developed on both surfaces although very faint.

stituents of latent deposits) is a contributory factor in dictating the quantity and quality of evidence likely to be obtained (Fig. 5).

Test 4—Product #86—2029-A Stronger Solution

Another area of study focused upon the hypothesis that an increase in the strength of the fuchsin solution should have a positive effect upon the volume and quality of evidence obtained.

The formula for the Fuchsin was increased from 0.02 g to 0.25 g (fuchsin) per 400 mL of methanol or water and test samples were processed with the results shown in Tables 5 and 6.

Evaluation

Test results show that given the increased strength in the Fuchsin solution, this did not necessarily guarantee successful or improved development of evidence in every case. In fact, there appeared to be a deterioration in the quantity of evidence developed on the smooth surface of some of the test samples.

In addition to the obvious increase in health risks that would also accompany such use of larger amounts of the chemical, it was not felt any improvement (in some cases) was significant enough to warrant serious consideration for the continued use of a stronger solution. Given the limited extent of the test procedures, the author would encourage further discussion with regard to this.

Test 5—Basic Fuchsin vs. Gentian Violet and Cyanoacrylate/Rhodamine 6G (Figs. 1–4)

The primary focus of this paper has been the study and evaluation of basic fuchsin and its value as a developmental technique within the field of forensic identification.

However, if it is to become a viable addition to the forensic arsenal it is important to know how the process would compare to the established techniques of gentian violet and cyanoacrylate ester fuming/rhodamine 6G. By setting in opposition both techniques

TABLE 4—*Fuchsin and water solution.*

Piece #1(B)	Identifiable impressions developed on both surfaces with clearer impressions noted on smooth surface.
Piece #2(B)	Good quality impressions developed on both surfaces although very faint.
Piece #3(B)	Identifiable impressions developed on both surfaces with clearer impressions noted on smooth surface.
Piece #4(B)	No identifiable impressions developed on adhesive surface. Good quality impressions developed on smooth surface although very faint.

TABLE 5—*Fuchsin and methanol solution.*

Piece #1(A)	Very faint but identifiable impressions developed on smooth surface although no discernable detail noted on adhesive surface.
Piece #2(A)	Good impressions developed on adhesive surface but negative results on smooth surface.
Piece #3(A)	Identifiable impressions developed on adhesive surface with very good quality impressions on smooth surface.
Piece #4(A)	Very good impressions developed on adhesive surface with faint but identifiable detail noted on smooth surface.

it was important to determine from an informational standpoint whether fuchsin could prove to be an equally or more effective processing technique.

Further test samples bearing donor prints were each cut into two halves ensuring each piece had a portion of the same deposited impression. One half was processed in the fuchsin and water[4] solution, then the adhesive surfaces of the remaining halves were processed in gentian violet ensuring the chemistry did not contaminate the smooth surface of the tape.

Fixed photographic paper was used to record the "transferred" impressions from each of the samples. The remaining smooth surfaces of tape were processed with the cyanoacrylate (glue) fuming process and treated with Rhodamine 6G laser dye.

The results of the subsequent laser examination are shown in Table 7.

Evaluation

The different developmental techniques used in these "limited tests" all produced evidence to varying degrees on each of the samples. However, closer analysis of the evidence quality showed superior results in many cases, were obtained from the Fuchsin process over those of gentian violet and cyanoacrylate fuming/R6G albeit with a reduction in contrast.

The rhodamine 6G appeared to cause a subsequent deterioration of ridge detail in some cases and staining was uneven with a lot of background interference, and lacked the homogeniety and consistency exhibited in the impressions developed by the fuchsin process.

Basic Fuchsin—An Illustration

The overall results of all tests on basic fuchsin products—86-202-9; 220-12; 85-734-3; 34032-26; 86-108-1 and R-665, and the percentage of successful development of

TABLE 6—*Fuchsin and water solution.*

Piece #1(B)	Good quality impressions developed on smooth surface. Negative results on adhesive surface.
Piece #2(B)	Reasonable quality impressions developed on adhesive surface. Very faint but identifiable detail noted on smooth surface.
Piece #3(B)	Excellent impressions developed on both surfaces.
Piece #4(B)	Very good quality impressions developed on both surfaces.

[4]For this particular test, the fuchsin and water solution was chosen over the methanol because of the encouraging results to date and to avoid repetition of test procedures.

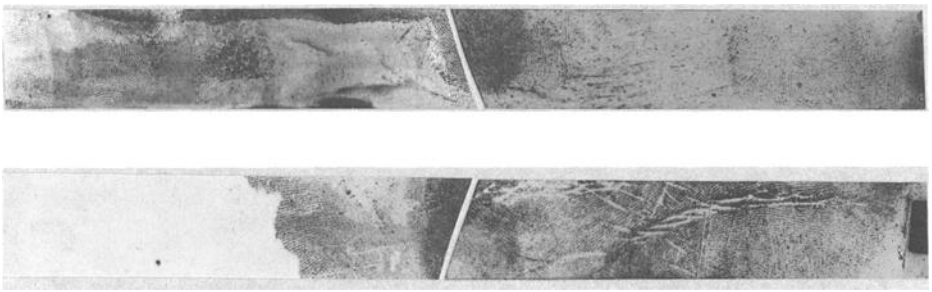

FIG. 1—*Test 5A. Basic fuchsin vs. gentian violet/C.A. (glue)/R6G. Piece A. C.A. (Glue)/R6G—smooth surface* (top left); *Basic fuchsin—smooth surface* (top right); *gentian violet—adhesive surface* (bottom left); *basic fuchsin—adhesive surface* (bottom right).

identifiable evidence from all test samples of tape using both water and methanol solutions is illustrated in Fig. 5.

From Fig. 5, a calculation of the combined results of Fuchsin's effectiveness on both recent and older latent impressions can be made to determine which product was the most successful in developing identifiable evidence of varying ages and on both surfaces of the tape (see Fig. 6). NOTE: The percentages used in these charts (Figs. 5 and 6) were calculated by combining the actual number of samples (tests 2 and 3) that produced *identifiable* evidence regardless of quality, and dividing by the total number of samples used.

Summary

Basic fuchsin is an industrially used organic dye commercially available from a number of chemical manufacturers.

Through the course of researching this product, it was found to possess staining abilities which could have a valid application as a developmental technique to the field of forensic identification.

The particular area of focus has been the processing of black electrical tape, which almost invariably shows up on many weapons or other crime-related exhibits.

The initial tests concerned themselves with the attempt at identifying the fuchsin 'reactor.' However, the subsequent results indicated the existence of several 'reactors'—

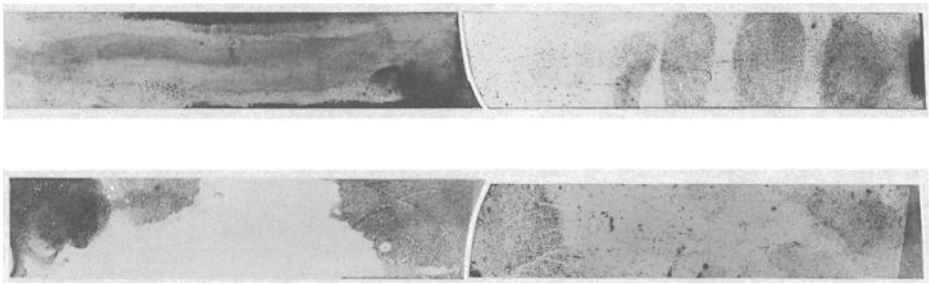

FIG. 2—*Basic fuchsin vs. gentian violet/C.A. (glue)/R6G. Piece B. C.A. (glue)/R6G—smooth surface* (top left); *basic fuchsin—smooth surface* (top right); *gentian violet—adhesive surface* (bottom left); *basic fuchsin—adhesive surface* (bottom right).

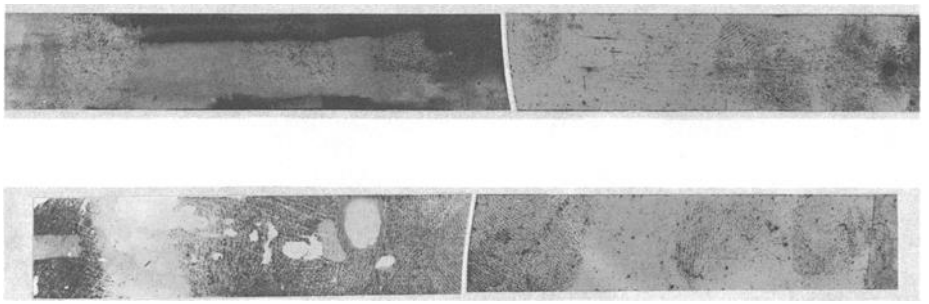

FIG. 3—*Basic fuchsin vs. gentian violet/C.A. (glue)/R6G. Piece C. C.A. (glue)/R6G—smooth surface* (top left); *basic fuchsin—smooth surface* (top right); *gentian violet—adhesive surface* (bottom left); *basic fuchsin—adhesive surface* (bottom right).

from the foreign materials of the household lubricants to the numerous constituents of a latent impression. (Further research into the chemistry of these products unfortunately exceeds my expertise.)

From these results, it was determined that basic fuchsin was capable of developing fingerprint evidence as a result of contamination from oil or grease so the objective of this research paper was focused on the development of evidence by the naturally occurring biological constituents of the latent impression.

To this end, a selection of different types of fuchsin were tested on numerous samples of tape bearing impressions with an age range from one day to one month old. The purpose of this was initially to determine which product would prove to be the most effective.

The subsequent testing procedures on both the 'recently deposited' and 'older' latents concluded that product no. 86-202-9 (Aldrich) produced the most favorable results overall, although encouraging results were also obtained from products no. 220-12; 85-734-3; 34032-26 and R-665; and 86-1081 respectively.

The next area of study looked at the comparison of methanol with water as the fuchsin carrying agent, and to see if there were any notable differences in their abilities to develop evidence.

The overall test results showed there was a relatively even distribution of positive development given to both solutions, with perhaps the water solution gaining a slight

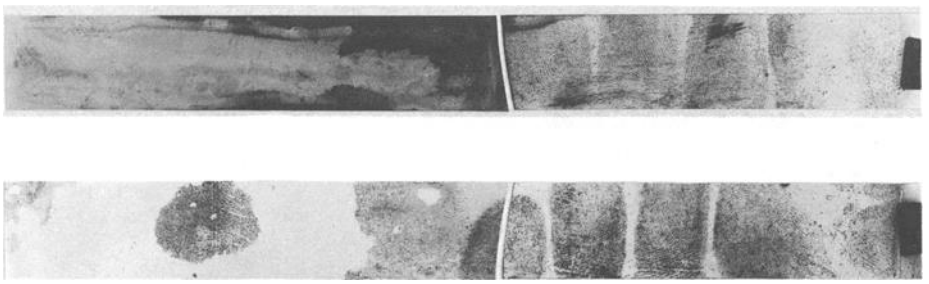

FIG. 4—*Basic fuchsin vs. gentian violet/C.A. (glue)/R6G. Piece D. C.A. (glue)/R6G—smooth surface* (top left); *basic fuchsin—smooth surface* (top right); *gentian violet—adhesive surface* (bottom left); *basic fuchsin—adhesive surface* (bottom right).

TABLE 7—*Comparing fuchsin results with gential violet/C.A./R6G.*

	Adhesive Surface		Smooth Surface	
Test Sample	Gential Violet	Basic Fuchsin	C.A./R6G	Basic Fuchsin
#1 (see Fig. 1)	Reasonably good quality impressions developed. Background staining noted although quality of impressions unaffected.	Very good quality impressions developed with good contrast. No background interference noted.	Very poor quality impressions developed although identifiable. Development "spotty" in appearance with loss of detail. Also background interference noted. Lack of ridge consistency.	Good quality impressions developed. Consistent development and clearer detail. Minimal background interference.
#2 (see Fig. 2)	Very good quality impressions developed. Background staining noted although quality of impressions unaffected.	Reasonably good quality impressions developed with good contrast. Minimal background interference.	Ridge detail developed although very poor quality but identifiable. Background interference.	Very good quality impressions developed. Minimal background interference.
#3 (see Fig. 3)	Poor quality impressions developed with some identifiable detail.	Reasonably good quality impressions developed. Adequate contrast.	Very poor quality impressions developed–identifiable. "Spotty" development with loss of detail. Lack of ridge consistency and some background interference.	Good quality impressions developed. Consistent development and clearer detail. Minimal background interference.
#4 (see Fig. 4)	Poor quality impressions developed although some identifiable detail.	Reasonable quality impressions developed with good contrast.	Good quality impressions developed with noted background interference. Uneven development affecting ridge detail.	Very good quality impressions developed. Minimal background interference.

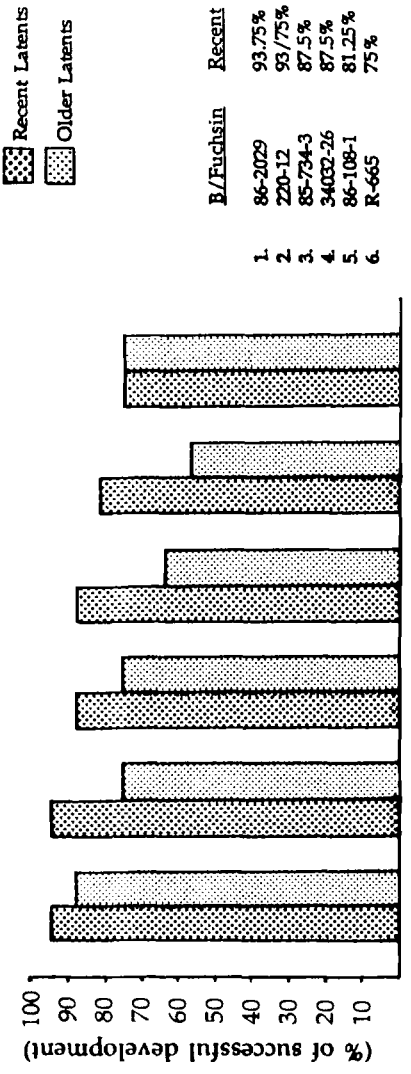

FIG. 5—*Results of development of identifiable evidence on both surfaces/methanol and water solutions.*

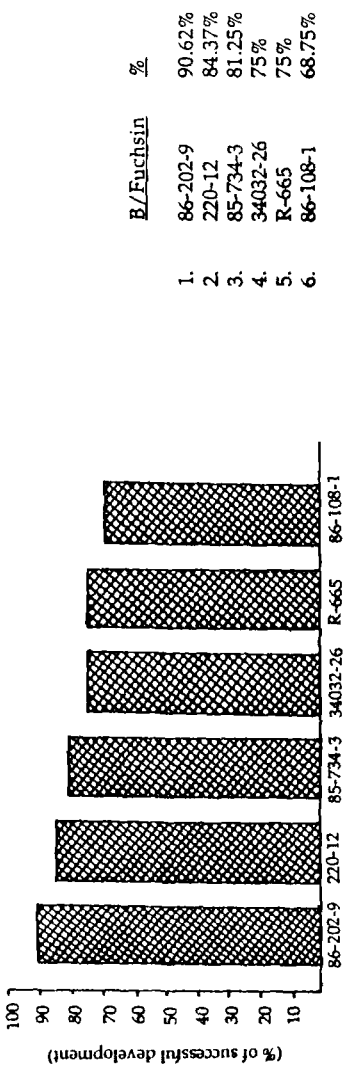

FIG. 6—*Combined results of basic fuchsin development of identifiable evidence of varying ages.*

advantage in some cases. Significantly, this provides the added bonus of being able to work with a solution less hazardous to both the user and the exhibit.

The following tests focused upon whether an increase in the strength of the solution would in theory produce even better results. In this case, there appeared to be a trade-off, in that many sample impressions, although exhibiting an improvement in contrast on the *adhesive* surface of the tape, did in many cases show a deterioration of quality and detail on the smooth surface of the tape. It was concluded at the time that consistency in the development of identifiable evidence on *both* surfaces of the tape was of greater importance and was best achieved with the original formula.

To date, all test results conducted have, in the author's opinion, been very encouraging. In the beginning, the stated purpose of this research was the examination of a 'one-step' method of processing electrical tape but in so doing, if fuchsin was to ever prove its worth, it meant having to compete against the firmly established techniques of gentian violet and cyanoacrylate fuming/R6G—certainly a formidable task.

The purpose of the final series of tests was designed to address that very prospect. The observations made of the test results found much of the evidence developed with fuchsin to be of a better quality than the C.A./R6G impressions and in my opinion, even marginally better than those developed with gentian violet.

The quality of the results obtained from these tests will, in some cases, be subjective and recommend they are best evaluated under your own test conditions.

A limited number of tests using the fuchsin process were also conducted on *other* types of adhesive tapes but without any notable success and as a result, no further research was carried out at that time.

Conclusion

The basic fuchsin process is a relatively simple technique to use and one that is reasonably inexpensive to purchase.

Through the course of this research, it was found to be an effective developmental technique for processing black electrical tape. The Basic Fuchsin product that has been the most effective overall is Product No. 86-202-9 (Aldrich) dissolved in a water solution.

It has shown successful results in developing good to excellent impressions on both surfaces of the tape with good clear ridge detail and with very little background interference.

However, one of the main problems encountered with this process has been the apparent lack of contrast, or very weak fluorescence of the evidence on many of the test samples. This, naturally, could pose some problems with the actual detection of evidence if it were examined with a less than diligent eye. This is why great emphasis has to be placed on conducting a very close and careful examination of the exhibit after processing has been completed ensuring, of course, that the heat from the alternate light source does not destroy the evidence.

In the samples that did show improved contrast or stronger fluorescence, it was found that this was usually due to the impressions consisting primarily of subaceous or foreign materials rather than naturally occurring latent deposits that appeared in the majority of the weaker impressions.

Once the evidence has been detected then the next step of recording the impressions with photography is reasonably straightforward.

However, in light of the problems already discussed and if we are to achieve the best possible results, this step does call for two things which are not always readily available in a busy field identification unit, namely time and patience. If these factors are applied, then there is no doubt, in the long run, the effort will prove to be worthwhile.

For anyone wishing to replicate these results, it is important to bear in mind the following points.

When testing a new technique such as basic fuchsin, the results of the laboratory tests that are often conducted under ideal conditions may not always be replicated in actual case exhibit examination, for example, the exhibit (tape) may have been exposed to the elements or subjected to heat or water damage, all of which could severely affect the success of this process, as they would any other.

Finally, I am not advocating the replacement of gentian violet with the basic fuchsin process for vinyl adhesive tapes because in fact, further research still needs to be conducted toward the development of a suitable fuchsin enhancement agent. However, the fuchsin process does offer a viable alternative as a one-step developmental technique due to the encouraging results obtained from the development of identifiable evidence in most of the tests conducted.

Acknowledgment

Special thanks to Brian Dalrymple for his assistance during the initial discussion of the Basic Fuchsin process.

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