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Small Particle Reagent: Developing Latent Prints on Water-Soaked Firearms and Effect on Firearms Analysis

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ABSTRACT: Small particle reagent (SPR) is a technique for developing latent prints on water-soaked items. Current research in processing wet firearms indicates that SPR may be a valid technique for developing latent prints with negligible effect on firearms analysis. Six different firearms each composed of different materials were immersed in water at time intervals ranging from eight to thirty-five days. At the end of the first and second phases, all firearms were processed for latent prints using SPR. A third phase involved using cyanoacrylate ester fuming followed by black powder as a generally accepted processing technique. Results of the experiment revealed that SPR yielded more suitable latent impressions than cyanocrylate ester fuming followed by black powder.

KEYWORDS: criminalistics, fingerprints, water-soaked material, ballistics, firearms identification, black powder, cyanoacrylate ester, molybdenum disulphide, small particle reagent, trigger pull, molybdenite

Small particle reagent (SPR) is a wet process for detecting the presence of latent fingerprints. Molybdenum disulfide, the powder in suspension, is very sensitive to lipid material found in fingerprint residue. Initially, SPR was developed for processing automobiles which had been exposed to extreme moisture, such as dew or rain. Later, SPR was used for processing a variety of water-soaked items. Although processing wet plastic items with SPR offered the best results, it may also be used on wax paper, glass, painted articles, ceiling tile, and metals, such as firearms [*1*].

When a wet firearm is received by a forensic science laboratory a plan must be established to maximize evidentary potential. In the past, the evidence receiving area was a battleground for opinions on which section should examine the firearm first. Firearms examiners expressed concern that corrosion would affect their examination and subsequent identification. Latent print examiners were concerned that valuable fingerprint evidence could be destroyed. SPR solves these problems: firearms can still be effectively processed for latent prints while the firearm is still wet, reducing effects of rust and corrosion [*2*].

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Methods

Materials

Molybdenum disulfide powder was obtained from Lightning Powder Co., Salem, Oregon. "Tergitol 7 (Anionic)" was obtained from J. T. Baker Co., Glen Ellyn, Illinois. Choline chloride was obtained from Fisher Scientific, St. Louis, Missouri.

SPR was prepared by first mixing the surfactant stock solution. The surfactant stock solution was prepared by combining 4 g of choline chloride and 8 mL of Tergitol 7 in 500 mL of distilled water. The working solution was prepared by adding 10 g of molybdenum disulfide powder to 50 mL of surfactant stock solution to form a gray paste in which all the dried powder is wetted. The paste was then added to 900 mL of distilled water to complete the preparation of the reagent [*3*].

Normally, tap water would be used as a rinse. This step was slightly modified by using a surfactant rinse. The surfactant rinse was prepared by adding 50 mL of the surfactant stock solution to 900 mL of distilled water. The introduction of the surfactant provided a more complete rinse.

Firearms

Gun 1 was a .32-caliber Secret Service Special with a patina finish (nonfinished with a light coat of rust). Gun 2 was a .25-caliber Raven Arms model MP-25 with a chrome finish. Gun 3 was a .22-caliber H and R model 930 with a nickel-plated finish. Gun 4 was a .32-caliber Clerke with a pot metal chrome-plated finish. Gun 5 was a .25-caliber F.I.E. Titan with a blued pot metal receiver and a chrome-plated slide and barrel. Gun 6 was a .38-caliber Colt Detective Special with a blued steel finish.

Procedure

In the first phase of the experiment it had to be determined if SPR could develop latent prints on water-soaked firearms and if it had any effect on firearms examination. Experimentation started with firearms examination. Because molybdenum disulfide powder is used as a lubricant [*4*], there was a possibility that the internal workings of the firearm could be affected. Furthermore, the individual characteristics of the barrel could have been altered. To account for this effect, each firearm was test-fired (Test 1) and trigger pull weights determined. These results would later be compared to test results after the firearms were processed with SPR.

After firearms examination, the six firearms were given to the latent fingerprint section where test prints were placed on them. All six weapons were immersed in water for eight to fourteen days. Four of the six firearms were removed from the water and processed with SPR. Processing with SPR is a two-step process involving application of the SPR and removal of excess powder using a surfactant rinse. A tray was filled with enough SPR to immerse the firearm completely. The particles were suspended in the SPR by agitation with a tongue depressor. The firearm was then immersed in the SPR for 45 to 60 s, allowing the particles to settle on the firearm. The firearm was removed and rinsed with the surfactant rinse using a squirt bottle. Before processing the other side, the suitable latent impressions were preserved. When background painting became a problem, more vigorous rinsing was attempted. However, caution had to be exercised not to eliminate any detail with additional rinsing. After rinsing, additional detail was documented before reprocessing. Because the particles settled on the uppermost surface, the firearm was turned over and reprocessed to allow the particles to settle on the opposite side. Both sides of the firearm were reprocessed three times using the above procedure. After processing, preservation of the suitable prints was achieved through photography and lifting. Latent prints developed with SPR were difficult to photograph because of poor contrast; lifting suitable prints usually offered better results. However, care had to be exercised when lifting a print because lifting tape did not adhere to the surface very well and slippage could occur.

Some difficulty was experienced in getting suitable latent impressions when making multiple lifts. It was noted after one lift that most of the fingerprint residue was destroyed. Because it is often desirable to make multiple lifts of the same impression, the remaining two firearms were packaged in water-filled plastic bags. The bags were placed in a refrigeration unit in an effort to make the lipid deposits more durable. After several hours they were removed from the water and processed with SPR. Refrigeration before any processing made the fingerprint residue more durable and facilitated reprocessing.

To determine if SPR would change the individual characteristics of the barrel or affect the firing mechanism, the firearms were returned to the firearms section for further examination. A dry cleaning patch was passed through the barrel followed by an oiled patch. Additional test shots were made (Test 2) and trigger pull weights determined. The results of this test were then compared to Test 1.

After firearms analysis, the weapons were once again given to the latent print section for the second phase of the experiment. In the latent print section, the outer portions of the firearms were cleaned and fresh test prints were placed on them. To simulate a more realistic time frame the firearms were immersed in water for 33 to 35 days to see if residue could still be detected. After being subjected to this condition, the firearms were removed from the tank and placed in water-filled plastic bags. Since better results had been obtained in the first phase when the firearms were refrigerated, all bags in this phase were placed in a refrigeration unit overnight. The next day all firearms were removed from the bags and processed using SPR, with the suitable latent impressions being preserved.

Under these controlled laboratory conditions, the success of SPR could not be evaluated fairly. Considering this, a control phase of the experiment was generated using cyanoacrylate ester fuming followed by black powder, which is a generally accepted processing technique [5]. The firearms were returned to the firearms section for additional test shots (Test 3) and trigger pull weights were determined. Again, after firearms analysis, the outer portions of the firearms were cleaned and fresh test prints were placed on the firearms. All six weapons were immersed in water for eight days, after which they were removed from the water and allowed to dry. After drying, the firearms were processed with cyanoacrylate ester fuming followed by black powder. All suitable prints were preserved by lifting, and the firearms were then returned to the firearms section for final analysis. In the firearms section, a dry patch was passed through the barrel, followed by an oiled patch. Final test shots were made (Test 4) and trigger pull weights determined. The results of this test were then compared to those of Test 3.

After the initial control experiment using the cyanoacrylate ester process, it was determined that one factor, the effect of water only on the weapon, had not been considered. Two firearms were selected to test the effect of water alone. The two firearms were cleaned and placed in a tank of water. They were removed at different time intervals and trigger pull weights were taken. Since the effect on individual characteristics in the barrel had not been significant in the previous experiments, test shots were not conducted.

Results

The results of the fingerprint experiment are summarized in Table 1. The firearms were processed in three phases. In the first phase, SPR was able to develop suitable impressions after the firearms were immersed in water for short periods of time. In the second phase, SPR was able to develop suitable impressions after the firearms were cleaned and reimmersed in water for extended periods of time. In the third phase, after the firearms were cleaned and fresh test prints placed on them, the firearms were placed in water for short

TABLE 1—*Number of suitable latent impressions developed: a comparison between SPR and cyanoacrylate ester fuming followed by black powder.*[a]

Gun No.	12 Days in Water Processed with SPR	35 Days in Water Processed with SPR	8 Days in Water Processed with CA-BP
1	0	0	0
2	5	5	3
3	1	0	1
4	3	0	0
5	3	1	0
6	1	0	0

[a]Because of the time factor all guns could not be processed on the same day. These figures reflect average time frames. Exact times are not significant. In all cases, the firearms were soaked in water for eight days or longer before processing with SPR to give cyanoacrylate ester and black powder the advantage.

periods of time as in the first phase. The firearms were dried and then processed with cyanoacrylate ester fuming followed by black powder. This process also revealed suitable latent impressions, but not as many as SPR.

The results of the firearms analyses are summarized in Tables 2 to 4. The firearms were examined before and after Phase 1 to determine the effect of SPR processing on firearms analysis. The firearms were also examined before and after Phase 3 to determine the effect of cyanoacrylate ester followed by black powder on firearms analysis. Finally, the effect of water alone was determined. The projectiles, breach face markings, firing pin impressions, extractor marks, and ejector marks on all of the test shots were identified to the original test without much difficulty. Minor changes were observed in the appearance of the striations in the land and groove impressions. The differences between Tests 1 and 2, after processing with SPR, were no more than what would normally be expected between two consecutive test shots. There were greater differences observed between Tests 3 and 4 after processing with cyanoacrylate ester fuming followed by black powder. Although these differences were quite

TABLE 2—*Comparison between Tests 1 and 2: net change of trigger pull weight (in lbs) due to effect of SPR processing.*

Gun No.		Test 1	Test 2	Net Change
1	SA[a]	3.5- 4.0	3.0- 3.5	−0.5
	DA[b]	>18.5	11.0-11.5	−7.5
2	SA	8.5- 9.0	7.5- 8.0	−1.0
	DA	NA[c]	NA	NA
3	SA	5.5- 6.0	5.0- 5.5	−0.5
	DA	13.0-13.5	13.0-13.5	no change
4	SA	6.0- 6.5	6.0- 6.5	no change
	DA	15.5-16.0	16.0-16.5	+0.5
5	SA	9.5-10.0	14.0-14.5	+4.5
	DA	NA	NA	NA
6	SA	6.0-6.5	6.0- 6.5	no change
	DA	11.5-12.0	12.0-12.5	+0.5

[a]SA = single action.
[b]DA = double action.
[c]NA = not applicable.

TABLE 3—*Comparison between Tests 3 and 4: net change of trigger pull weight (in lbs) due to effect of cyanoacrylate ester fuming followed by black powder processing.*

Gun No.		Test 3	Test 4	Net Change
1	SA[a]	NF[b]	NF	NA[c]
	DA[d]	11.5-12.0	12.0-12.5	+0.5
2	SA	7.5- 8.0	7.5- 8.0	no change
	DA	NA	NA	NA
3	SA	5.0- 5.5	5.5- 6.0	+0.5
	DA	13.0-13.5	13.5-14.0	+0.5
4	SA	5.0- 5.5	5.0- 5.5	no change
	DA	15.0-15.5	15.0-15.5	no change
5	SA	12.0-12.5	12.0-12.5	no change
	DA	NA	NA	NA
6	SA	5.5- 6.0	5.5- 6.0	no change
	DA	12.0-12.5	12.0-12.5	no change

[a]SA = single action.
[b]NF = not functional.
[c]NA = not applicable.
[d]DA = double action.

TABLE 4—*Net change of trigger pull weight (in lbs) due to effect of immersion in water.*

Days in Water	Trigger Pull Weight			
	Gun No. 1		Gun No. 2	
0	SA[a]	7.0- 7.5	SA	5.0-5.5
	DA[b]	11.0-11.5	DA	NA[c]
2	SA	7.0- 7.5	SA	5.5-6.0
	DA	11.0-11.5	DA	NA
5	SA	7.5- 8.0	SA	5.5-6.0
	DA	11.0-11.5	DA	NA
8	SA	7.5- 8.0	SA	5.5-6.0
	DA	11.0-11.5	DA	NA
13	SA	8.5- 9.0	SA	5.5-6.0
	DA	11.5-12.0	DA	NA
17	SA	8.5- 9.0	SA	5.5-6.0
	DA	12.0-12.5	DA	NA
20	SA	9.0- 9.5	SA	5.5-6.0
	DA	14.5-15.0	DA	NA
26	SA	9.0- 9.5	SA	5.5-6.0
	DA	14.5-15.0	DA	NA
Net Change:	SA	+ 2.0	SA	+ 0.5
	DA	+ 3.5	DA	NA

[a]SA = single action.
[b]DA = double action.
[c]NA = not applicable.

evident, they were not much more than what might be considered normal differences, and no difficulty was experienced in comparison of the bullets.

Discussion

There are both disadvantages and advantages in using SPR. Disadvantages associated with latent fingerprint analysis are that it is a messy technique, it takes a long time to dry, large articles require the spray technique, developed prints are very fragile, developed prints are difficult to photograph, lifting tape does not readily adhere to the surface, and only one side can be processed at a time. Processing with SPR is advantageous to the latent fingerprint examiner because it is inexpensive, wet items can be processed effectively, SPR will adhere to prints developed by cyanoacrylate ester fuming, developed prints do not fade, there is no need for specialized equipment, and there is low health risk. It is also advantageous to the firearms examiner because there is minimal effect on firearms analysis and it is easier to remove from the firearms than cyanoacrylate ester and black powder.

SPR would appear to be a valid technique for processing water-soaked firearms. In no instance did cyanoacrylate ester fuming followed by black powder outperform SPR. Overall, SPR yielded more suitable latent prints than cyanoacrylate ester fuming followed by black powder. In some instances, processing with SPR revealed suitable impressions after the firearms were submerged in water for one month, whereas processing with cyanoacrylate ester fuming followed by black powder revealed fewer impressions when the firearms were submerged for only one week.

Furthermore, it appears that the general effect on trigger pull weight by SPR is to decrease it slightly, whereas cyanoacrylate ester fuming followed by black powder either increases the weight or does not change it at all. Although both methods provide reliable results, it appears that SPR preserves the individual characteristics of a firearm better than cyanoacrylate ester fuming followed by black powder. SPR is a technique suggested by the British Home Office for use on most types of wet, nonporous surfaces and is a method that can be recommended for the laboratory as well as crime scene use.

Comments

Reference was made to the spray technique in the discussion section. Note that this method of application was not used in our experimentation because SPR is most effective when the particles are allowed to settle on the object. The spray method should be reserved for objects too large to process using the tray method.

This paper is not meant to be an exhaustive research of the full potential of SPR. The technique was developed by the British Home Office, and this paper is intended to introduce SPR to examiners in the United States. The purpose of this paper was to provide a possible solution to problems that are encountered when processing wet firearms for latent print evidence.

Our research had benefited greatly from research already conducted by the British Home Office in London. At the conclusion of this project, we obtained a copy of the British Home Office Manual of Fingerprint Development Techniques and noted that their formula has changed. We cannot report on the new formula, which follows, since we have not had the opportunity to use it:

Preparation of concentrated solution:
- Detergent solution (surfactant stock):
  - 500-mL tap water
  - 4-mL Tergitol 7
- add detergent solution (while stirring) to:
  - 50-g molybdenum disulfide powder

Preparation of working solution (dish development):
add 4.5-L tap water to concentrated solution
Preparation of working solution (spray application):
add 3.0-L tap water to concentrated solution

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