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Development of Sweat Latent Fingerprints on Common Coated Fabrics

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Abstract: With the continuous social development and progress, people impose increasing higher functional requirements for clothing. Coated fabrics thus came into being. At present, research on sweat latent fingerprints on fabric is mostly based on traditional fabric materials and relatively lags behind. In view of this, common PVC, PU, PA and PTFE coated fabrics were selected as bearing bodies of sweat latent fingerprints in this paper. Through series of experiments, it was found that coated fabrics were different from conventional fabrics, whose sweat latent fingerprints could be treated and developed by traditional powder development method and "502" glue fumigation method. However, ninhydrin development method is not suitable for the development of sweat latent fingerprints on the above four kinds of coated fabrics. This study serves as a preliminary exploration for latent fingerprint development on coated fabrics.

1. Introduction

In some vicious crime scenes such as murder, rape and robbery cases, the criminal may leave sweat fingerprints on the victim's clothing. Domestic and foreign researches about the sweat latent fingerprints mostly focus on development of sweat latent fingerprints on different fabrics [1-4]. However, with recent rapidly increasing material life level of people, people also have increasingly higher requirement for clothing. In addition to the design, cutting of clothing, people have more demand for texture, functional performance for clothing when buying clothes. Coated fabrics as one of the branches thus appeared. However, sweat latent fingerprints on the coated fabric are rarely studied, so this research has practical significance for public security work.

2. Introduction to Common Coated Fabrics

Coated fabric is a special textile fabric treated by special technology. Through coating technology, the fabric can achieve various functional effects, such as waterproof, anti-loss of down coat so on. According to different coating materials, common coated fabrics can be divided into five categories: PVC coating (polyvinyl chloride resin), PU coating (polyurethane resin), half-PU coating, PA (acrylic resin) and special coating material such as PTFE coating (Teflon) [5].

The substrate of coated fabrics is very complex, including cotton fabric, chemical fiber, polyester fabric, polyamide fabric, nylon fabric, non-woven fabric, glass fiber, etc. Different substrate materials combined with different coatings will enable better performance of the fabric [5].

Coated fabric products come in several varieties, mainly used in sports clothing, down clothing, simulation leather jacket, awning hood, outdoor tents, bags and suitcases, mountaineering clothing, raincoat & umbrella, etc.

3. The Method and Principle of Sweat Latent Fingerprint Development in this Experiment

3.1. Powder Development Method

The powder development method uses the adsorption effect of fingerprint material on the powder to develop latent fingermarks, fresh sweat latent fingerprints. Where, moisture plays a major role in the adsorption process [6].

3.2. Ultrafine Particle Suspension Development Method

Ultrafine particle suspension development technology mainly use water-insolubility of grease and sweat mixed with dirt in fingerprint and the principle that fine particles in suspension can be absorbed by grease and sweat mixed with dirt. A colored coating is formed on the surface of testing material with suspected fingerprints to develop latent fingerprints on the surface. At the same time, it can be used as a dye to stain the sweat latent fingerprints after "502" glue fumigation [6].

3.3. Ninhydrin Development Method

The ninhydrin development method is mainly to let ninhydrin react with amino acids in sweat to generate purple complex and then develop sweat latent fingerprints [7-9].

3.4. "502" Glue Fumigation and Staining Enhancement

The main component of "502" glue, α-ethyl cyanoacrylate, undergoes anionic polymerization under water and weak base, thus presenting the sweat latent fingerprint in the form of white polymer. If the contrast between the sweat latent fingerprint and the bearing background is not strong or the fingerprint ridgeline are not consistently fractured after "502" glue fumigation, subsequent staining enhancement method can be used for enhancement. At present, the commonly used methods include "502" gentian violet staining, "502" Rhodamine 6G staining, "502" BBD staining, etc. In case of heavy staining, absolute ethanol, etc. should be used for rinsing [10-12].

4. Experimental Preparation

4.1. Experimental Equipment and Inspection Materials

Black magnetic powder, silver powder, ninhydrin, magnetic brush, quantitative filter paper, T-1 "502" glue (Beijing Chemical Factory), rhodamine 6 G, fluorescent green ultrafine particle suspension (Shenyang Zhongqiao Zhuoyuan Technology Co., LTD.), ninhydrin fumigation cabinet, (Beijing Bulante Police Equipment Co., Ltd.), 445 nm laser light source, yellow light filter, orange red light filter, anhydrous ethyl alcohol, acetone, multi-band light source, Nikon D7100 SLR camera.

Light color, black 190T Lotaf PVC coated polyester cloth, light color, black PU transparent glue coated chemical fiber cloth, 210D bright silver PA coated Oxford waterproof cloth, black PA coated Oxford cloth, white PTFE Teflon double-sided coated fabric, coffee color PTFE Teflon double-sided coated fabric.

4.2. Preparation of Sweat Latent Fingerprint Sample

Eight kinds of coated fabric testing material were cut into several 4 cm * 6 cm squares. The sealer washed hands so that hands were free from other stains. After natural drying, the seal wore disposable PVC gloves to generate sweat for 5 minutes. When stamping the fingerprint, the experimenter tore open the PVC glove so that the ten fingers could stamp while maintaining consistent latent sweat quantity. After the seat latent fingerprints were stamped, leave the sealer's hands uncovered in the natural state for 4 hours, and then the above steps were repeated to make the sweat latent fingerprint samples. The sweat latent fingerprint samples were stored at room temperature.

4.3. Preparation of Rhodamine 6G Staining Solution

0.1g rhodamine 6G powder was put into a beaker, 100ml absolute ethanol was added, dissolved completely, and transferred to a brown dropping bottle for preservation.

4.4. Preparation of Ninhydrin Developing Solution

4g ninhydrin powder was weighed and put in a beaker, added with 100ml acetone, dissolved completely, and transferred to a brown dropping bottle for preservation.

5. Experimental Results and Discussion

5.1. Development of Fresh Sweat Latent Fingerprint on Coated Fabric by Black Magnetic Brush Development

Magnetic brush was used to dip black magnetic powder, and the sweat latent fingerprint was developed on four kinds of light-colored coated fabrics, as shown in Figure 1.

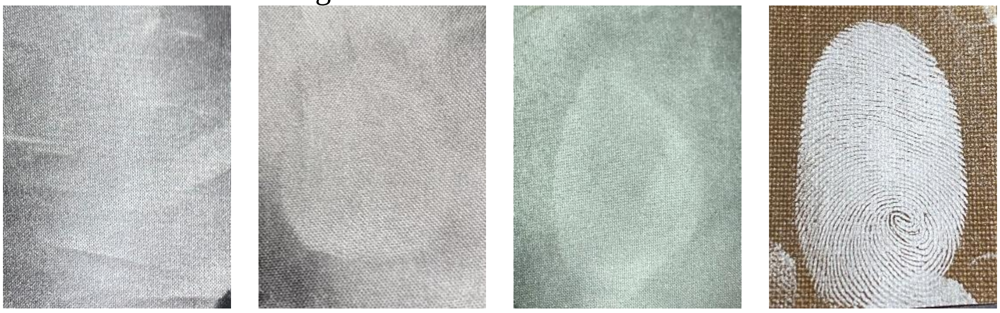
a (PVC cloth) b (PU cloth) c (PA cloth) d (PTFE cloth)

Figure 1: Development of fresh sweat latent fingerprint on coated fabric by black magnetic brush development

It can be seen from Figure 1 that the black magnetic brush has a poor development effect on the fresh sweat latent fingerprints on the four kinds of coated fabrics, and the fingerprint characteristics are not obvious. The PVC coated fabrics have no fingerprints at all after brush development. After brush development of PU coated fabrics, only the outline features of the fingerprint can be observed, but the fingerprint ridgelines are extremely blurred. Only incoherent fingerprint ridgelines can be observed on PA coated fabric after brush development. Only fingerprint outline is displayed on PTFE coated fabric after brush development, but there are no fingerprint ridgeline characteristics. None of the above has the condition for identification.

5.2. Development of Fresh Sweat Latent Fingerprint on Coated Fabric by Silver Brush Development

Silver brush was used to display the fresh sweat latent fingerprints on four kinds of dark coated fabrics, with the results shown in Figure 2.



a (PVC cloth) b (PU cloth) c (PA cloth) d (PTFE cloth)

Figure 2: Development of fresh sweat latent fingerprint on coated fabric by silver brush development

Figure 2 shows that the fresh sweat latent fingerprint is difficult to show on the dark PVC coated fabric after silver brush development. Only outline of fresh sweat latent fingerprint can be observed on the dark PU coated fabric after silver brush development, which is not qualified for identification. Only outline of fresh sweat latent fingerprint can be observed on the dark PA coated fabric after silver brush development, which is not qualified for identification. The developed fresh sweat latent fingerprints have fine ridgelines and obvious characteristics on the dark PTFE coated fabric after silver brush development, which is qualified for identification.

5.3. Development of Fresh Sweat Latent Fingerprint on Coated Fabric by "502" Glue Filter Paper Attachment Method

The coated fabric with fresh sweat latent fingerprints was spread on a clean table. The "502" glue was evenly smeared on the quantitative filter paper. When there was no floating liquid on the quantitative filter paper, touch the area with "502" glue. When it was not sticky, the quantitative filter paper was covered on the sweat latent fingerprints to be developed on the medical surgical masks, and then covered with big glass like quantitative filter paper for 5～10 minutes. Observe from time to time. When obvious fingerprint ridgelines appear, stop fumigation and take photos before fixture. The effect is shown in Figure 3.

Figure 3 shows that the "502" glue filter paper attachment method has very good development effect on PU, PA, PTFE-coated dark fabrics. The developed fingerprint has fine ridgelines and obvious characteristics, which is qualified for identification. For the light-colored cloth coated with PU, PA and PTFE, follow-up treatment is needed to enhance the contrast due to the poor contrast. For PVC coated fabric, "502" glue filter paper attachment method shows poor development effect, which is unqualified for identification.

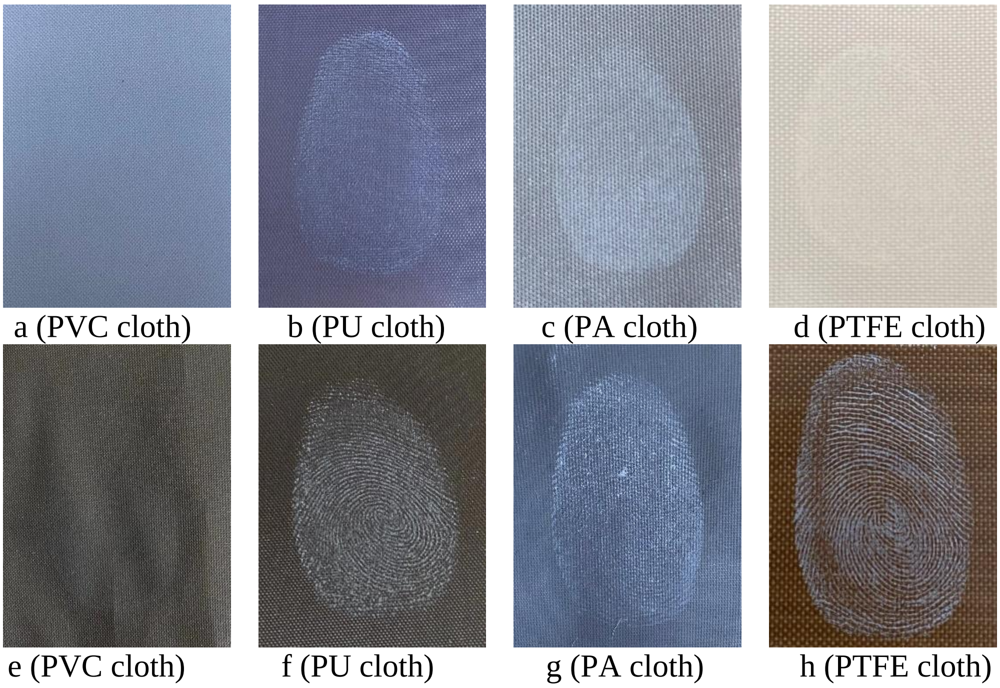


Figure 3: Development of fresh sweat latent fingerprint on coated fabric by "502" glue filter paper attachment method

5.4. Enhancement of Sweat Latent Fingerprints by Rhodamine 6G Stained"502" Glue

The prepared rhodamine 6G solution was dropped to the sweat latent fingerprint on coated fabrics after "502" glue fumigation, rinsed with absolute ethanol until there was no rhodamine 6G in the background of coated fabric. Then, 445nm laser light source was used for excitation, photographed and fixed through orange red filter. The effect is shown in Figure 4.

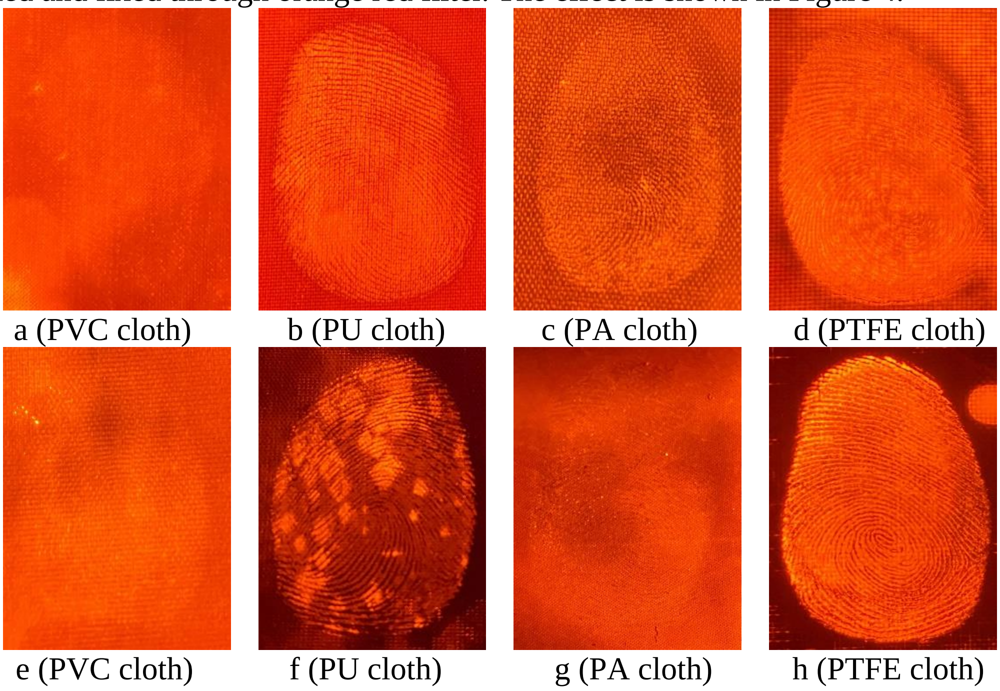


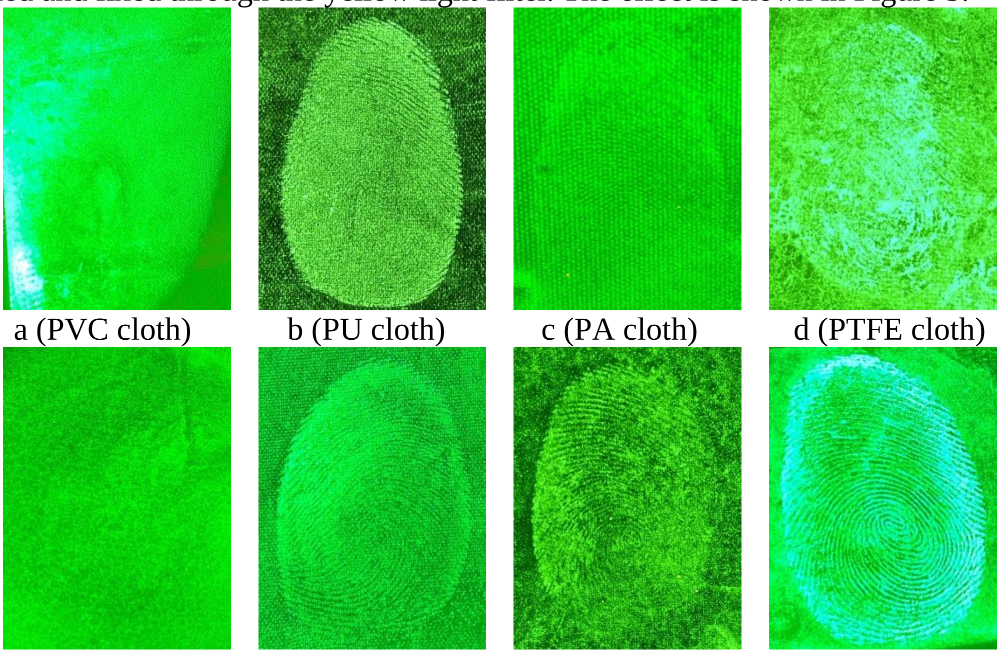
Figure 4: Enhancement of sweat latent fingerprints by Rhodamine 6G stained"502" glue

(a-d is development of sweat latent fingerprints on light-colored coated fabrics by rhodamine 6G fluorescence enhanced "502", e-h is development of sweat latent fingerprints on dark-colored coated fabrics by rhodamine 6G fluorescence enhanced "502")

Figure 4 shows that the fresh sweat latent fingerprints on coated fabrics show obvious enhancement effect after "502" fumigation-enhanced rhodamine 6G staining. Where, PTFE coated fabric has the best development effect, with clear and exquisite fingerprint ridgelines, which meets the identification conditions. PU coated fabric has good development effect, showing relatively fine fingerprint ridgelines and meeting the identification conditions. PA coated fabric shows general development effect, with a certain amount of fingerprint ridgelines displayed. PVC coated fabric has poor development effect, only showing the fingerprint outline and a small number of fingerprint ridgelines, which is unqualified for identification.

5.5. Enhancement of Sweat Latent Fingerprints by "502" Glue Stained with Fluorescent Green Ultrafine Particle Suspension

The fluorescent green ultrafine particle suspension was sprayed on the sweat latent fingerprint on the coated fabric with "502" glue fumigation and washed with water until no suspension existed in the background of the coated fabric. The suspension was excited with multi-band light source, photographed and fixed through the yellow light filter. The effect is shown in Figure 5.



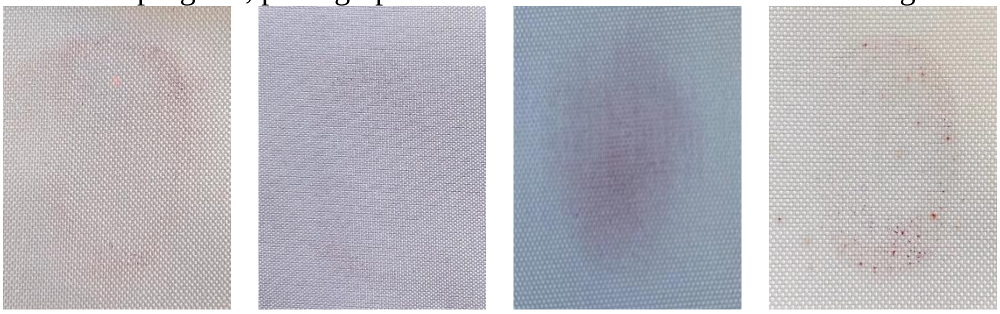
(a-d is development of sweat latent fingerprints on light-colored coated fabric by fluorescent green ultrafine particle suspension-enhanced "502", e-h is development of sweat latent fingerprints on dark-colored coated fabric by fluorescent green ultrafine particle suspension-enhanced "502")

Figure 5: Enhancement of sweat latent fingerprints by "502" glue stained with fluorescent green ultrafine particle suspension

Figure 5 shows that the enhancement effect of PVC coated fabric is unobvious. The fingerprint ridgelines on the PU coated fabric are relatively fine and qualified for identification. The dark PA coated fabric has superior development effect on sweat latent fingerprints than light PA coated fabric, which has certain identification value. The dark PTFE coated fabric has the best development effect on sweat latent fingerprint, showing fine fingerprint ridgelines and obvious characteristics, which meet the condition for identification.

5.6. Development of Sweat Latent Fingerprint on Coated Fabric by Ninhydrin Development Method

The configured ninhydrin solution with a concentration of 4% was dropped onto the four kinds of light-colored coated fabrics. After drying in the shade, it was placed in the ninhydrin fumigation cabinet for automatic program, photographed and fixed. The effect is shown in Figure 6.



a (PVC cloth) b (PU cloth) c (PA cloth) d (PTFE cloth)

Figure 6: Development of sweat latent fingerprint on coated fabric by ninhydrin development method

Figure 6 shows that, by the ninhydrin development method, which is often used to develop sweat latent fingerprints on permeable objects, it is difficult to develop sweat latent fingerprints on PVC, PU, PA, and PTFE coated fabrics, which indirectly verifies that the coated fabrics are semi-permeable or non-permeable objects.

6. Conclusion

The powder development method has poor fresh sweat latent fingerprint development effect on the common four types of coated fabrics. Where, PVC coated fabrics have big surface adhesion, and fingerprints cannot be developed by brushing the three kinds of powders. The powder development method can only show the outline characteristics of the fingerprint on PU and PA coated fabrics. PTFE coating is non-permeable with smooth surface. When using powder development method, powder forming great contrast with the object background color in the same particle size as silver powder should be selected.

"502" glue filter paper attachment method can be used as the preferred method for developing fresh sweat latent fingerprints on PU, PA, PTFE coated fabrics. When there is not big contrast between the development effect and the background, rhodamine 6G, fluorescent suspension staining methods can be used for enhancement. The developed fingerprints have fine ridgelines and clear characteristics, which meets identification conditions.

Ninhydrin development method is not suitable for the development of sweat latent fingerprints on PVC, PU, PA and PTFE coated fabrics.

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