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Development of Sweat Latent Fingerprints on Medical Surgical Masks

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Abstract: Criminals have increasing counter-detection awareness. Some of them evade monitoring by wearing masks. Moreover, the outbreak of COVID-19 pandemic makes medical surgical masks more commonly used. In some criminal crime scenes, the public security organ often extracts DNA information from the facial mask on the scene, ignoring development of its latent fingerprints. In this paper, the sweat latent fingerprints on medical surgical masks were successfully developed by "502" glue fumigation. The BBD fluorescent staining was used to enhance the development effect, making it possible to develop the sweat latent fingerprints on the outer layer of medical surgical masks, which provides reference ideas for solving the problems in public security work.

1. Introduction

Fingerprints vary among different people, remain basically unchanged throughout the whole life and leave marks on touch with objects, which are thus widely used in personal identification [1]. However, criminals have increasing counter-detection awareness. Some of them evade monitoring by wearing masks. Moreover, the outbreak of COVID-19 pandemic makes medical surgical masks more commonly used. In some criminal crime scenes, the public security organ often extracts DNA information from the facial mask on the scene, ignoring development of its latent fingerprints. For its reason, medical surgical masks have special textile structure, making technicians think it difficult to extract the latent fingerprints on them. As a result, other channels are used to lock criminal suspects at the expense of excessive manpower and material resources. At present, for the development of sweat latent fingerprints on general fabrics, "502" glue fumigation is generally adopted according to a large number of scholars' studies [2-6]. Regarding whether it is applicable to sweat latent fingerprints on the outer layer of medical surgical masks with special material and textile technology, scholars have not studied it yet. Considering the actual practical needs of public security, the development of latent fingerprints on medical surgical masks is an important topic in the research field of fingerprint development.

2. Introduction to the Structure and Performance of Medical Surgical Masks

Most medical masks in China are made of polypropylene nonwovens and generally adopt three-layer structure (spunbonded nonwovens + melt-blown nonwovens + spunbonded nonwovens, SMS structure for short). Where, the upper and lower layers are polypropylene fiber nonwoven fabrics, with one or more layers of polypropylene filter meltblown cloth with a bacterial filtration rate of 99.9% added in the middle. The layers are welded by ultrasonic wave [7]. The SMS structure of a medical surgical mask is shown in Figure 1.

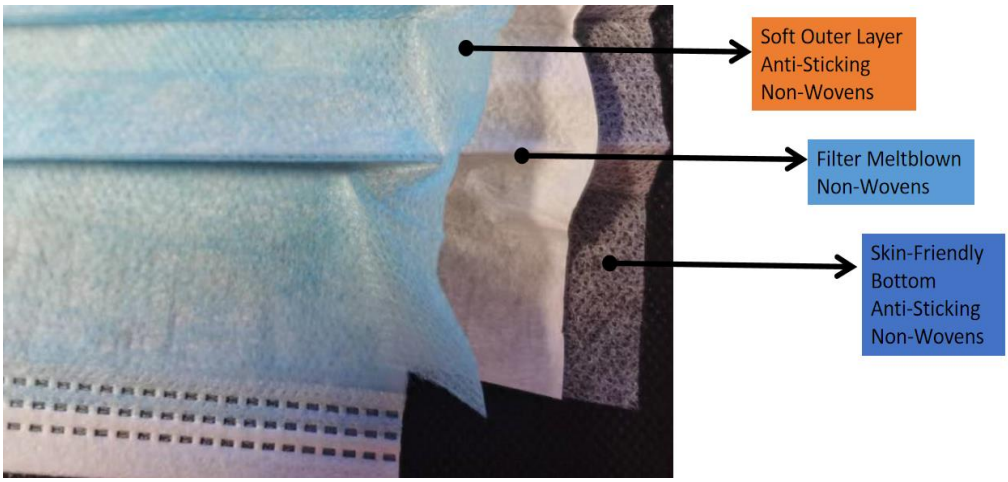


Figure 1: SMS structure of a medical surgical mask

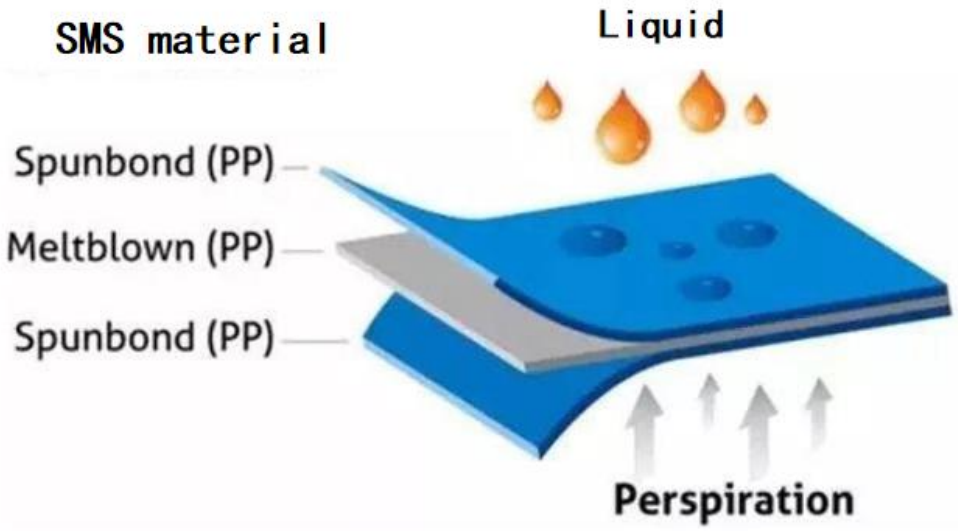


Figure 2: SMS structure permeability of medical surgical masks

SMS composite nonwovens can well barrier melt-blown nonwovens, while spunbonded nonwovens have high strength. These two technologies are combined to produce SMS composite nonwovens with complementary advantages. SMS composite nonwovens are composed of three layers of nonwovens. The upper and lower layers are high-strength spunbonded nonwovens, and the middle layer is high-barrier melt-blown cloth. Melt-blown cloth is a kind of dense microfiber layer with very small gap between the fibers, which can well barrier particles and microorganisms in the air. The SMS material in the middle layer has excellent barrier and filtration property, while the

spunbonded outer layer has high strength and good comfort, so it is widely used in medical textile materials (such as protective clothing, isolation clothing, disinfection cloth, etc.) [8]. As shown in Figure 2, in terms of material characteristics, ordinary SMS nonwovens lack complete permeability resistance to blood, water and alcohol [9].

3. The Principle of Latent Fingerprint Development by "502" Glue Fumigation

"502" glue fumigation is often used to develop latent fingerprints on impervious, semi-permeable objects. Its main composition is alpha ethyl cyanoacrylate. Its monomer has a strong electron-withdrawing cyanogroup and ester group, making it easy to undergo anionic polymerization under water and weak base, so that sweat latent fingerprints will be developed in the form of white polymer. If the contrast between the sweat latent fingerprints and the bearing background is not strong or the fingerprint ridgelines are not consistently fractured after "502" glue fumigation, subsequent staining enhancement methods can be used for enhancement. Currently, the commonly used methods include "502" gentian violet staining, "502" Rhodamine 6G staining, "502" BBD staining, etc. [10-12].

4. Experimental Materials and Methods

4.1. Equipment and Reagents

Blue medical surgical mask (YY 0469-2011), T-1 type "502" glue (Beijing Chemical Factory), qualitative filter paper, electronic balance, beaker, glass rod, drop irrigation, SLR camera, 445nm laser light source, color filter, BBD, Rhodamine 6G, acetone, absolute ethanol.

4.2. Experimental Methods

4.2.1. Object Selection

Winner blue medical surgical masks conforming to YY 0469-2011 “Medical Surgical Mask Standard” were selected as objects.

4.2.2. Preparation of Sweat Latent Fingerprint Samples

Before making the fingerprint sample, the sealer first washed hands with soap, dried them naturally, wore disposable PVC gloves to produce sweat for 5 minutes, and then left sweat latent fingerprints on the medical surgical mask with natural force. (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 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.)

4.2.3. Preparation of "502" Staining Solution

Rhodamine 6G staining solution: 0.1g rhodamine 6G powder was weighed and put into a beaker, then added with 100ml absolute ethanol; BBD staining stock solution: 0.1gBBD powder was dissolved in 50ml acetone; BBD staining working solution: 5mlBBD staining stock solution was added into 495ml absolute ethanol [13].

4.2.4. Operations for Sweat Latent Fingerprint Development and Enhancement

Step 1: "502" glue filter paper attachment for fumigation. The medical surgical mask with 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 spread 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 whether there were fingerprint ridgelines from time to time.

Step 2: Stain enhancement and rinsing. An appropriate amount of staining liquid was dropped by dropper to the white fingerprint ridgeline of the medical surgical mask after "502" fumigation, and then dried in the shade. After drying, rhodamine 6G stained specimen was excited by 532nm green laser light source and observed through orange-red light filter. The BBD-stained specimens were excited by a 445nm blue laser light source and observed through an orange light filter. If the development effect of sweat latent fingerprints is ideal, photograph directly. If the background is stained too much and the sweat latent fingerprints are not obviously developed, rinse with absolute ethanol until the effect is ideal.

Step 3: Photography and fixture. The medical surgical mask treated in step 2 was dried in the shade in a dark environment, and the corresponding laser light source was selected for excitation according to the different staining methods. Then, photograph and fix through the corresponding light filter.

5. Experimental Results and Discussion

5.1. Development of Sweat Latent Fingerprints on the Outer Surface of Medical Surgical Masks by "502" Glue Fumigation

Figure 3 shows the development effect of fresh sweat latent fingerprints on the outer layer of medical surgical mask by "502" glue filter paper attachment method.

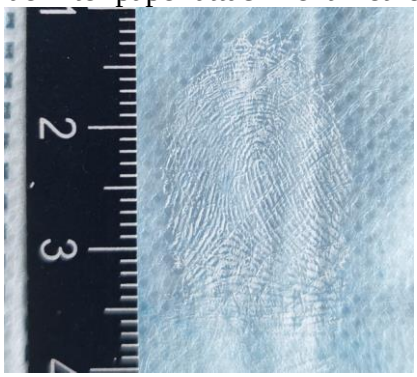
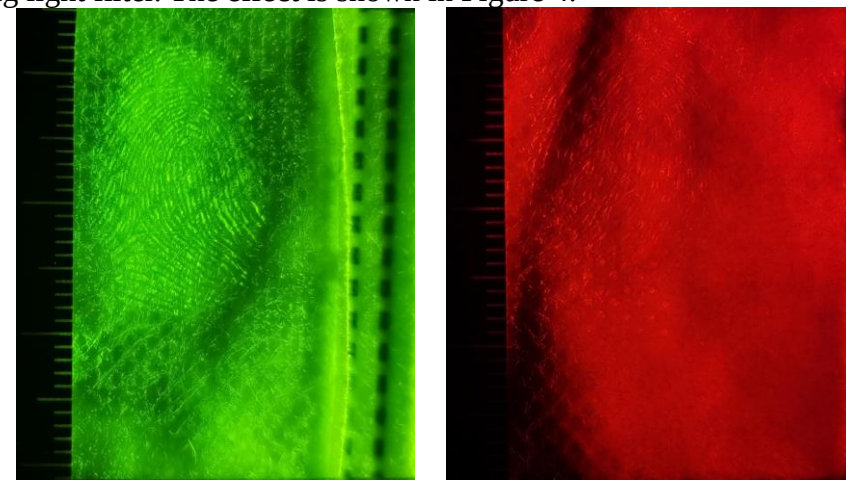


Figure 3: Development effect of fresh sweat latent fingerprints on the outer layer of medical surgical mask by "502" glue filter paper attachment method

Figure 3 shows that the outer surface of the medical surgical mask has a special texture, showing regular concave and convex phases, and the surface is uneven, which belongs to rough object. "502" glue fumigation can develop fresh sweat latent fingerprints on the outer surface of medical surgical mask, and the development effect is refined and can be used for identification. However, the white color in development is close to the light blue color of the outer layer of medical surgical mask. There is no contrast, so subsequent staining is needed to enhance the contrast.

5.2. Fluorescence Staining Method of "502" Glue Fumigation

The sealer stamped fresh sweat latent fingerprints of ten fingers, which were then processed by "502" glue filter paper attachment method, followed by BBD staining and enhancement treatment, and the obtained specimen was Group 1. After an interval of 4 hours, the sealer stamped fresh sweat latent fingerprints of ten fingers, which were processed by 502 "glue filter paper attachment method, followed by rhodamine 6G staining and enhancement treatment. The obtained specimen was Group 2. The one with the best development effect was selected from group 1 and group 2. The corresponding excitation light source was selected, followed by photography and fixture through the corresponding light filter. The effect is shown in Figure 4.



a. BBD treatment effect b. Rhodamine 6G treatment effect

Figure 4: Development effect of fresh sweat latent fingerprints on the outer layer of medical surgical masks by "502" glue fumigation fluorescence staining

Figure 4 shows that the fresh sweat latent fingerprints on the outer layer of medical surgical masks treated by "502" glue filter paper attachment can be enhanced by colorant. Where, BBD fluorescent staining method is superior to rhodamine 6 G staining method, showing clear, natural sweat latent fingerprint ridgelines in refined way, which is qualified for identification. However, specimen treated with rhodamine 6G had incoherent fingerprint ridgelines, only with obvious fluorescent spots in the depression, which did not meet the condition for identification.

5.3. Development of Sweat Latent Fingerprints Left in Different Time on the Outer Layer of Medical Surgical Masks by "502" Glue Fumigation

The sealer stamped fresh sweat latent fingerprints of ten fingers on the outer layer of medical surgical masks. After 1h, the ultrasonic atomizer was used to humidify the left fingerprint for 2s at a distance of 10cm, and then "502" glue filter paper attachment method was used for fumigation. The one with the best effect was selected, as shown in Figure 5.

Figure 5: Development effect of sweat latent fingerprints left 1h ago on the outer layer of medical surgical mask by "502" glue filter paper attachment method

Figure 5 shows that, for the sweat latent fingerprints left 1h ago on the outer layer of the medical surgical mask, only the finger outline can be observed by "502" fumigation after humidification, which is not qualified for identification.

6. Conclusion

A series of experiments showed that the fresh sweat latent fingerprint on the outer layer of medical surgical mask could be developed by "502" glue fumigation, and the developed fingerprint ridgelines were fine and qualified for identification. BBD fluorescent staining is more suitable for the enhancement of sweat latent fingerprints on the outer layer of medical surgical masks after "502" glue fumigation. "502" glue fumigation can barely develop old sweat latent handprints on the outer layer of medical surgical mask.

Acknowledgement

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