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Comparative Study on the Display of Sweat Fingerprints of 22 Different Permeability Carriers with a Combination of Laser and Indenedione

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ABSTRACT 445nm and 532nm lasers were used to visualize the sweat fingerprints on various 22 objects sprayed with indenedione solvent, and to compare and analyze the visual effects. It has the function of inspiration and reminder for the actual crime scene investigation. In the actual investigation process, it is necessary to further expand the scope of extraction on the scene.

KEY WORDS Forensic science; Crime scene investigation; Laser; Sweating fingerprints; Fluorescence; Manifestation

Due to the complexity and diversity of the scene, there are often a large number of potential biological traces that cannot be observed with the naked eye, especially potential sweat fingerprints. These potential biological traces play a very critical role in the detection of cases and litigation. There are a variety of equipment and methods used to realize the visualization of this part of the potential biological traces, such as magnetic powder method, multi-band light source visualization method, short-wave ultraviolet visualization method, fluorescent powder method and other equipment and methods. These devices and methods are on site. Investigation and identification of physical evidence have played a very important role in actual combat, but these equipment and methods have high requirements on site conditions, types and materials of objects, etc., and have great limitations. They are not effective in the appearance of potential biological traces. high. After the laser is widely used in field investigation and physical evidence identification actual combat work, the laser has shown a good effect on the display of biological traces, and has shown excellent effects on the potential fingerprints on the white wall, semen, body fluids, and some blood stains. The appearance characteristics. However, the use of lasers to directly visualize potential biological traces, especially the sweat fingerprints on various objects, also shows great shortcomings, such as the potential sweat fingerprints on various difficult objects such as stones and bricks, and the use of laser visualization methods, etc. Various methods cannot achieve the manifestation of potential biological traces on these objects. Through continuous research and practice, we have found that with the help of nindione fluorescent solvent and laser irradiation, it is possible to realize the appearance of potential biological traces on many difficult objects.

1. THE PRINCIPLE OF LASER AND INDENEDIONE TO REVEAL BIOLOGICAL TRACES

The display of biological traces with indenedione is a kind of chemical display method. Indenedione has a very high sensitivity to amino acids in biological traces and is easy to combine with amino acids in biological traces to react, while indenedione is a kind of strong fluorescence. The reagent emits a strong orange fluorescence under a certain intensity of green light. Before the popularization of lasers, the green light of a multi-band light source was generally used to

irradiate potential biological traces stained with nindione to excite fluorescence. The efficiency of fluorescence excitation was not very high. After the popularization of lasers, due to the monochromaticity and coherence of lasers The characteristics of fluorescein has a significant advantage in exciting fluorescence, which allows many traces of potential biological traces to be clearly displayed under the action of nindione.

2. MATERIALS AND METHODS

2.1 Experiment equipment

The selected laser is a dual-band laser material evidence surveyor (445nm, 532nm, XS-L-MINI-G8, Suzhou Xiaosong Technology Development Co., Ltd.), and the shooting equipment is a Canon 5D Mark II SLR camera, equipped with a yellow filter and an orange filter.

The selected objects include printing paper, cardboard, book paper, kraft paper, newspaper, coated paper, machine-printed invoices, kraft packaging boxes, facial tissues, paper cups, packaging boxes for Sanjiu cold granules, second copy of express order, natural toilet paper, flowers Cloth, bricks, stones, plywood, marble, white tiles, beige stone, granite, rusty iron rods.

2.2 Experimental methods

The use of indenedione solution to show potential biological traces generally adopts the method of immersion or spray display. Considering the convenience of operation in the field investigation work, we adopt the method of spray display. According to the ratio of 1,2-indenedione 0.8g, ethyl acetate 90ml, glacial acetic acid 10ml, ZnCl2 storage solution 80ml, ethyl acetate 1ml ratio, configure the indenedione solution, put it into a watering can to spray dye the sample, then spray, Dry the sample with hot air, and then irradiate the dyed sample with a laser, so as to realize the appearance of potential biological traces.

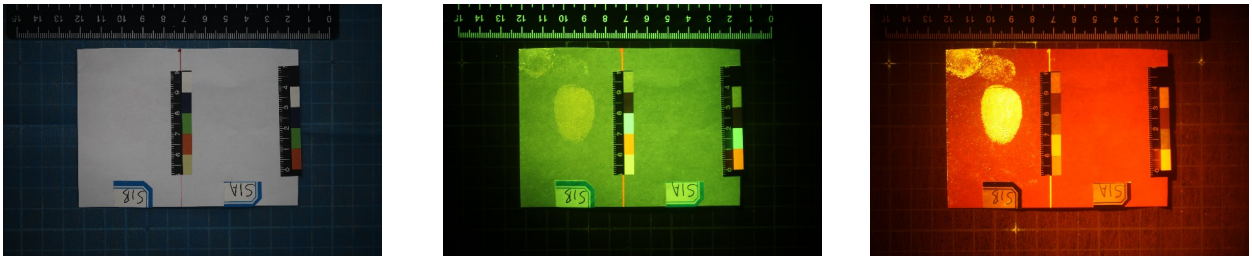
1) Divide each inspection material into two areas, left and right areas, and press the fingerprint in each area;

2) Spray dye one of the areas with nindione solvent, and then dry it with a hair dryer;

3) Use 445nm laser and 532nm laser to excite fluorescence, and use Canon 5D Mark II SLR camera with corresponding yellow or orange filter to capture the traces.

3 RESULTS

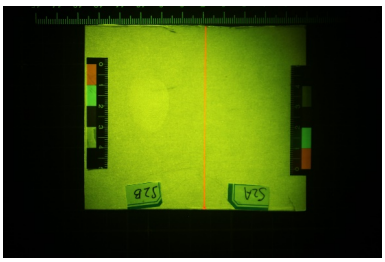
Figure 1 - 22 show the appearance of the sweat fingerprints on 22 different objects under the excitation of 445nm laser and 532nm laser, treated with indenedione and without indenedione treatment. Table 1 shows these 22 fingerprint lines and fingerprint traces on each object are compared. Table 1 is compared from two aspects. One is the sharpness of fingerprint lines, which is mainly to reflect whether the displayed fingerprint meets the comparison conditions. It is divided into " There are four levels of "clear, clear, fuzzy, and very fuzzy", among which the fingerprints of "clear" and "clearer" have the identification conditions; the other is the clarity of fingerprint traces, mainly to reflect whether the displayed fingerprints can be clear Positioning, so that subsequent trace extraction can be performed for DNA inspection. It is divided into three levels of "obvious, more obvious, and inconspicuous", among which "obvious" and "obvious" traces can be clearly used for subsequent DNA inspection. It can be seen from the figure and table that on some objects such as printing paper and cardboard, after using 445nm laser excitation, the fingerprint lines can be well displayed, and the fingerprint traces can also be clearly displayed, and the use of 532nm laser excitation , There are more objects, such as toilet paper, three plywood, etc., which can clearly show fingerprint lines, and except for the packaging box of Sanjiu Cold Granules, the rest of the objects can clearly show fingerprint marks.



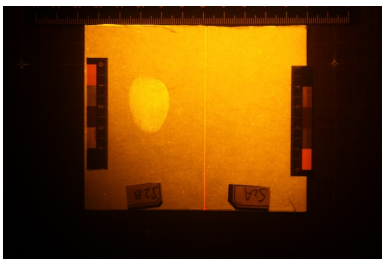
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 1 The effect of the printer paper

a. overview

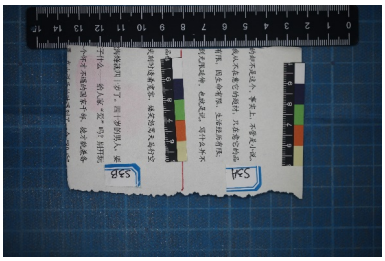


b. 445nm laser excitation

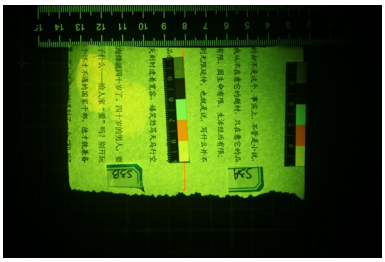


c. 532nm laser excitation

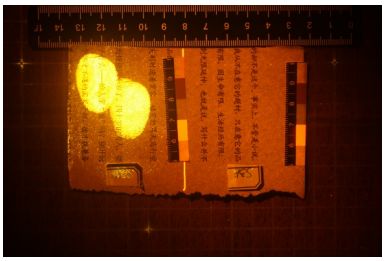
Fig. 2 The effect of cardboard



a. overview

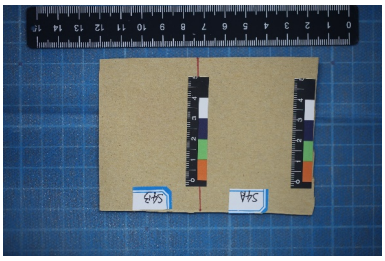


b. 445nm laser excitation

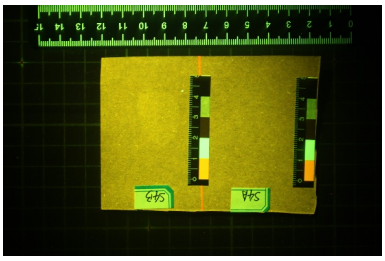


c. 532nm laser excitation

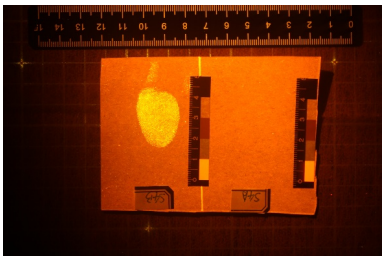
Fig. 3 The effect of book paper



a. overview

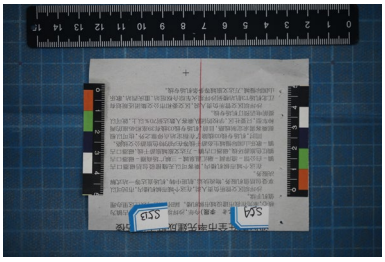


b. 445nm laser excitation

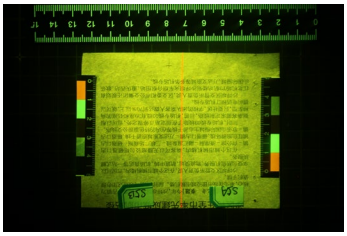


c. 532nm laser excitation

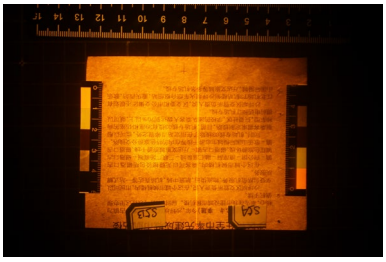
Fig. 4 The effect of kraft paper



a. overview



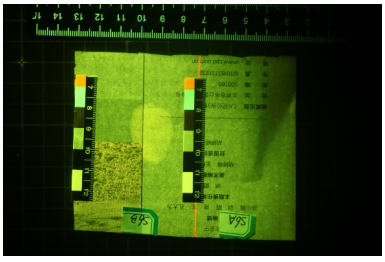
b. 445nm laser excitation



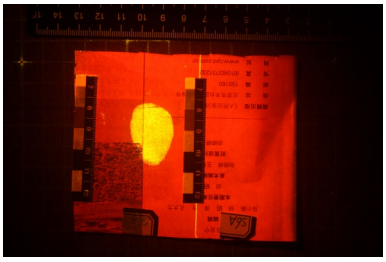
c. 532nm laser excitation

Fig. 5 The effect of the newspaper

a. overview

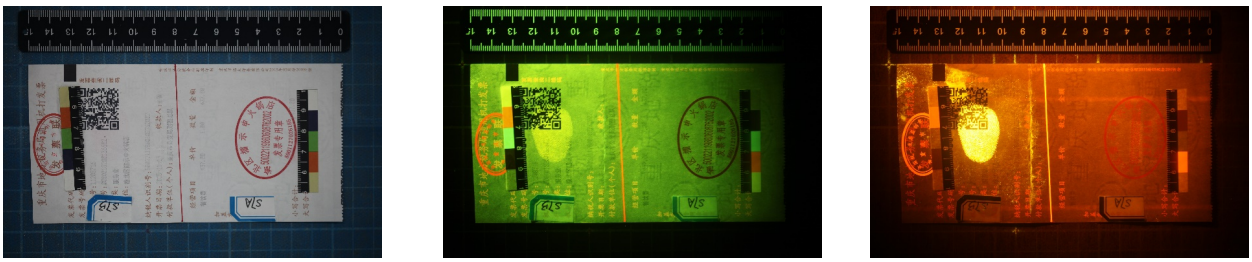


b. 445nm laser excitation



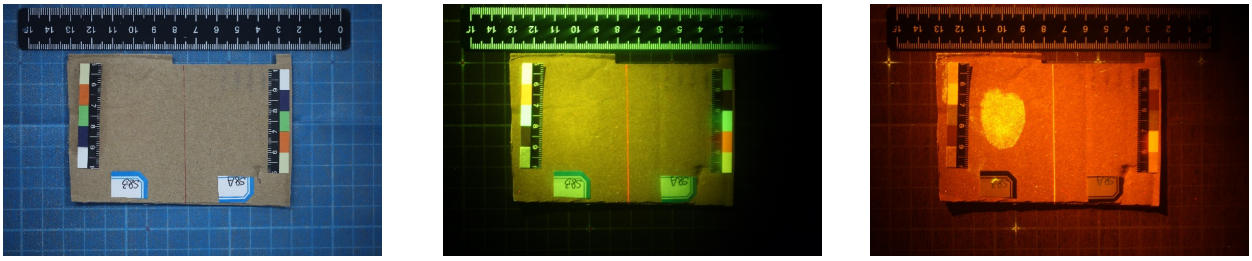
c. 532nm laser excitation

Fig. 6 The effect of coated paper



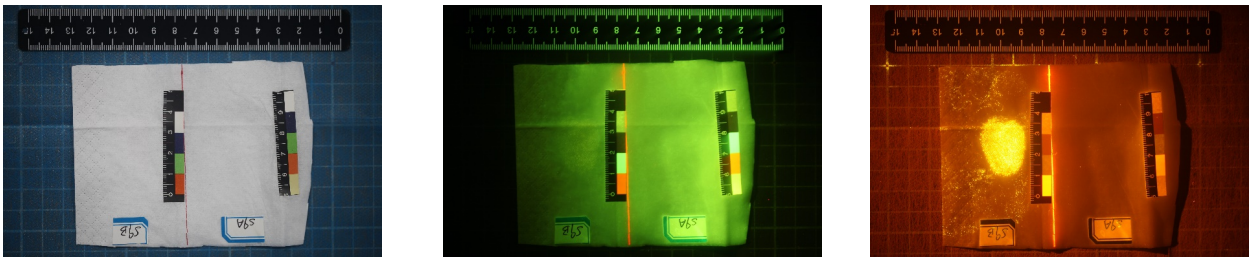
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 7 The effect of machine-printed invoices



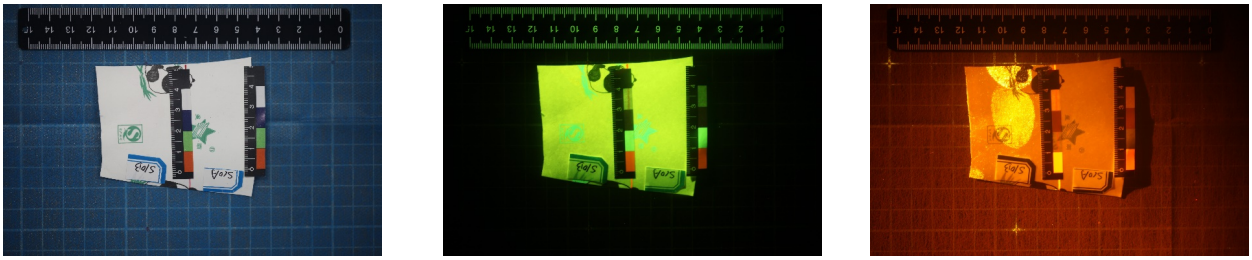
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 8 The appearance effect of corrugated wrapping paper



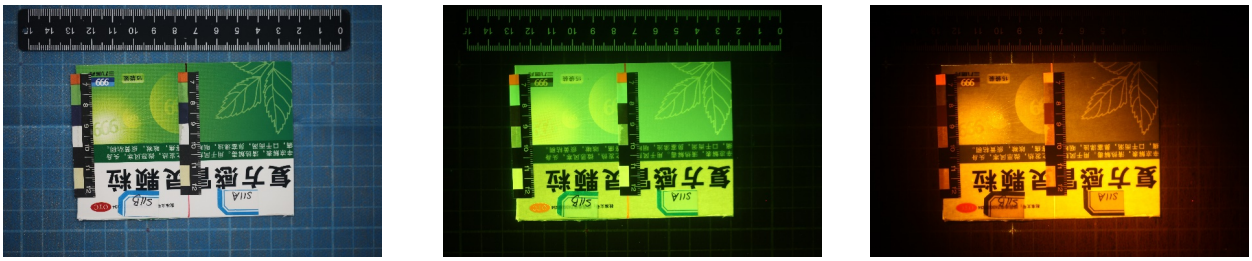
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 9 The appearance of the second page of the facial tissue



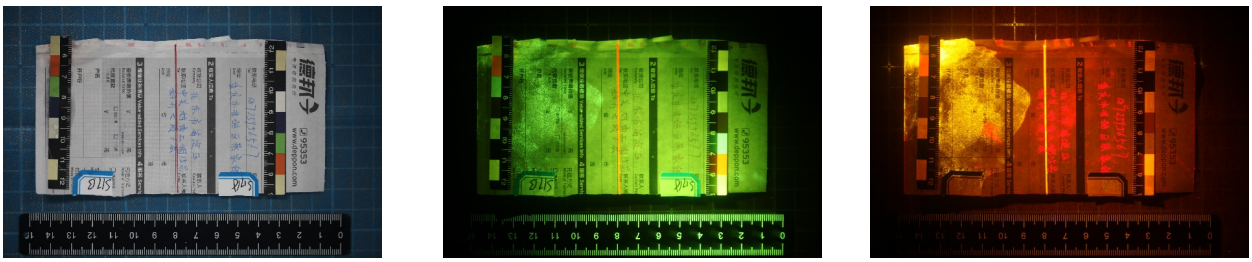
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 10 The appearance of the second page of the paper cup



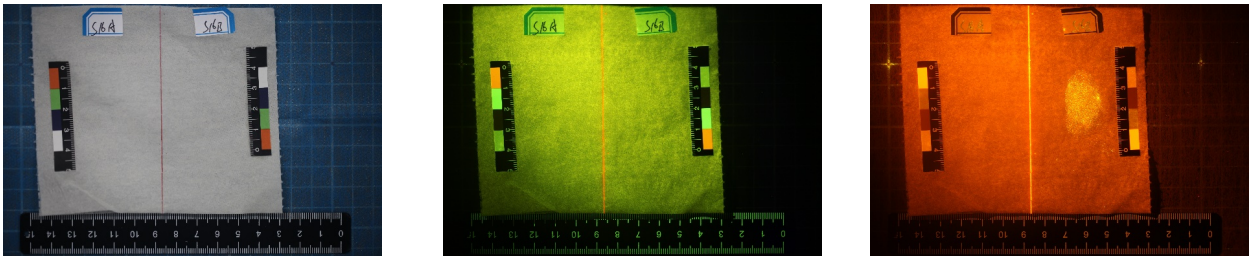
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 11 The appearance of the second page of common cold medicine packaging box



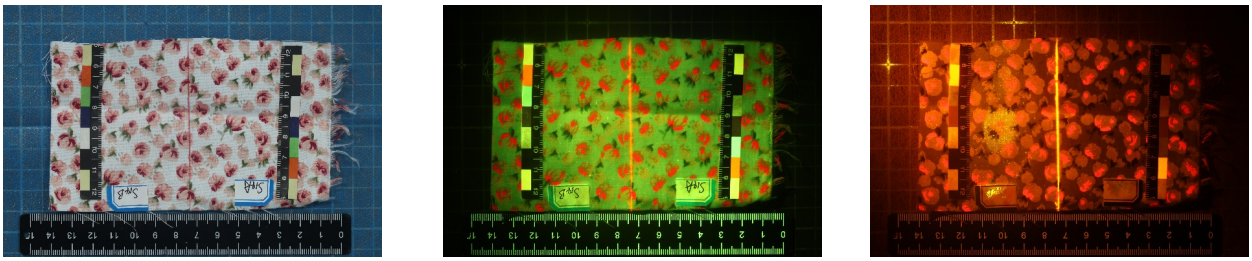
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 12 The appearance of the second page of the courier bill



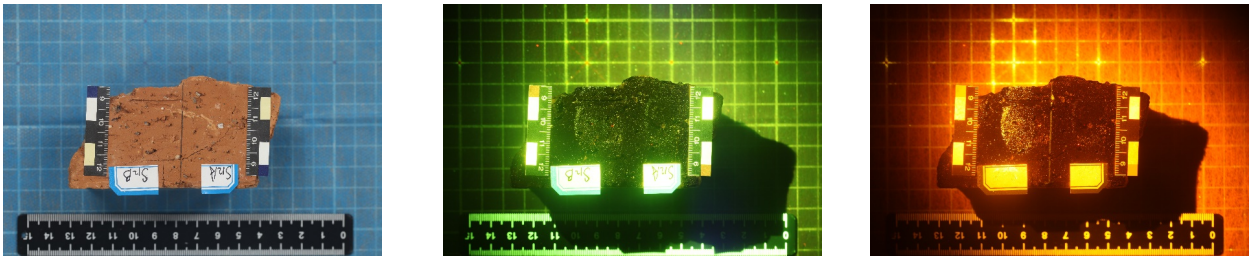
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 13 The appearance of the natural toilet paper



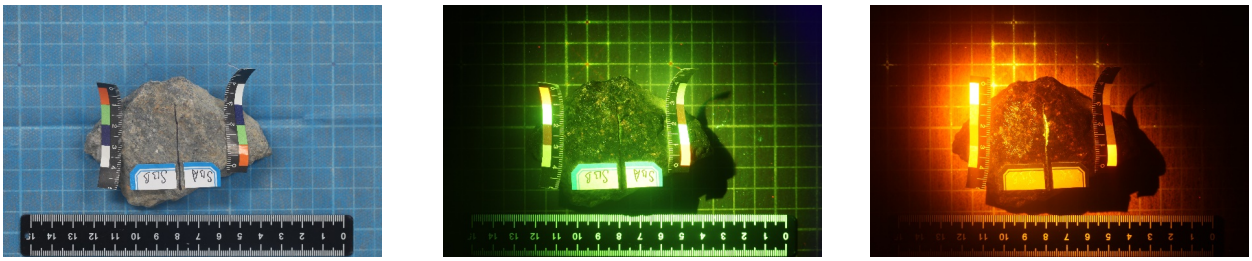
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 14 The appearance of the floral cloth



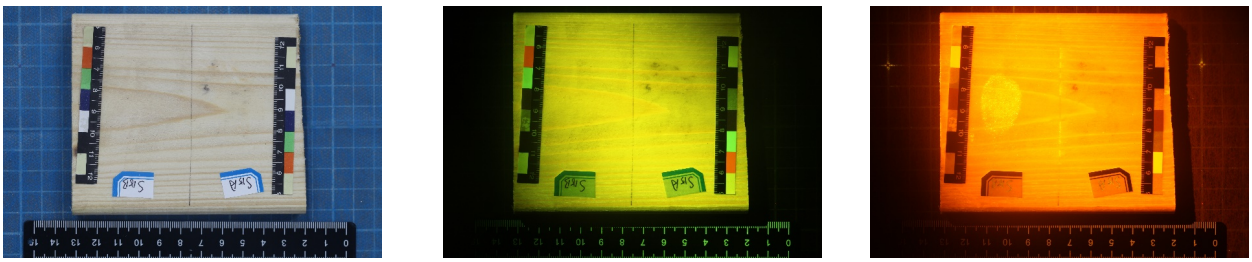
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 15 The appearance of the brick



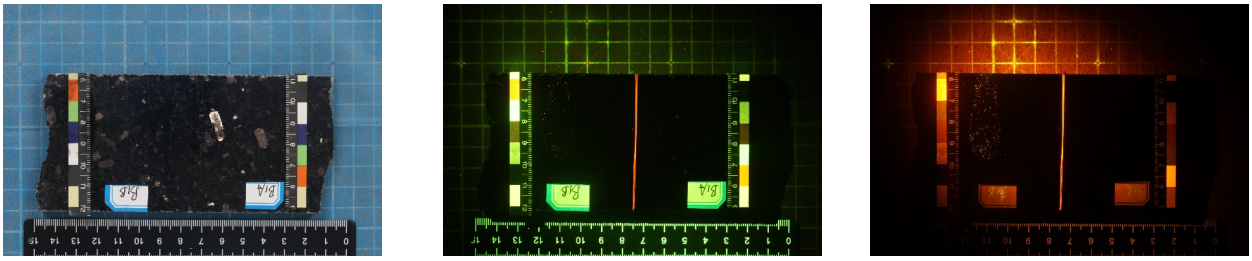
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 16 The appearance of the stone



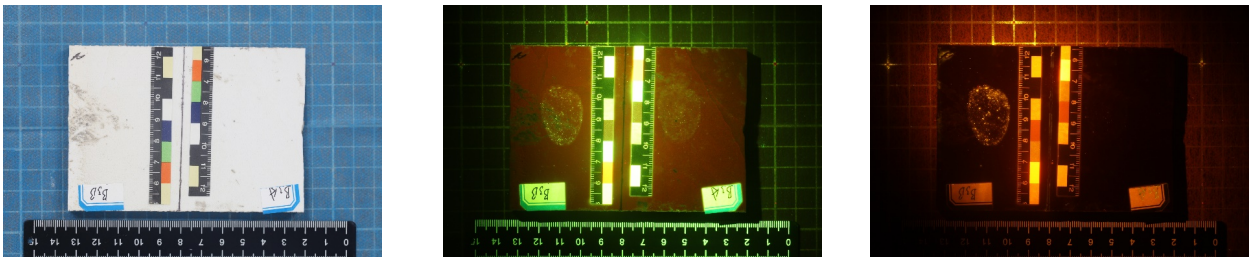
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 17 The appearance of the three plywood



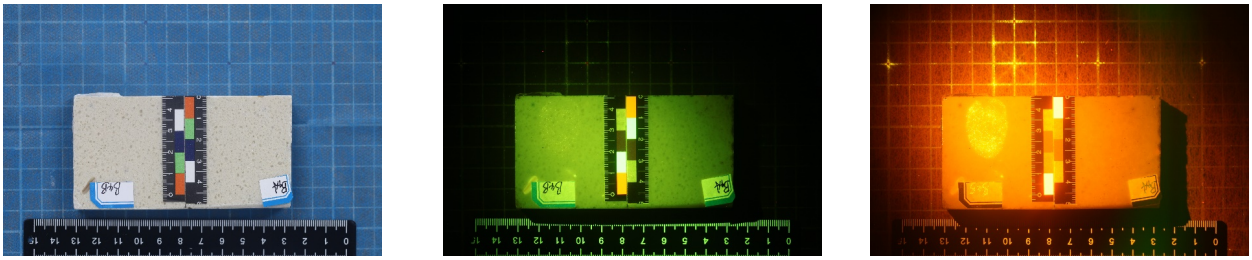
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 18 The appearance of marble



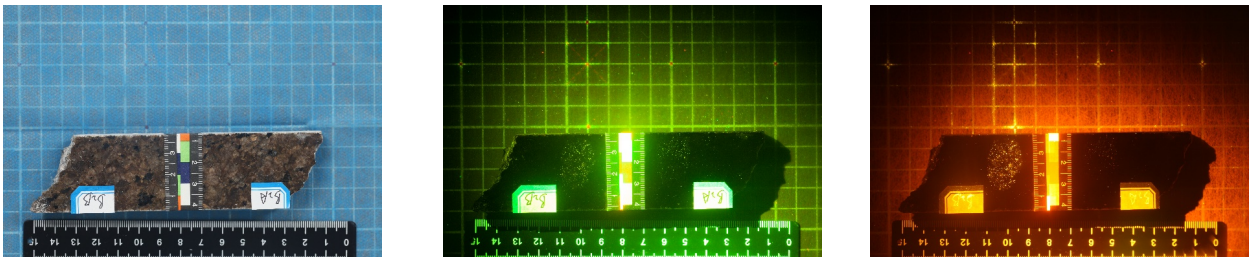
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 19 The appearance of white tiles



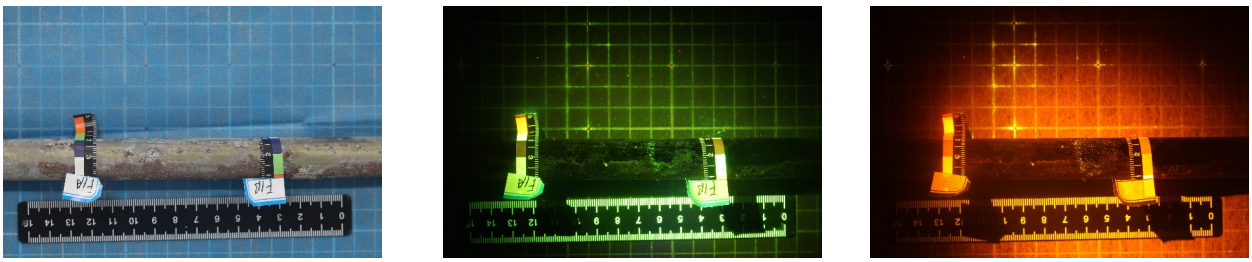
a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 20 The appearance of beige stone



a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 21 The appearance of granite



a. overview b. 445nm laser excitation c. 532nm laser excitation

Fig. 22 The appearance of rusty iron rods

Table 1 The potential sweat fingerprints on different objects are treated with nindione and then irradiated with 445nm laser and 532nm laser. The results are compared.

	Inspection materials	445nm laser excitation		532nm laser excitation	
		Line definition	Trace clarity	Line definition	Trace clarity
1	Printer paper	Clear	More obvious	Clearer	Obvious
2	Cardboard	Clear	More obvious	Clearer	Obvious
3	Book paper	Clear	More obvious	Clearer	Obvious
4	Kraft paper	Vague	More obvious	Clearer	Obvious
5	Newspaper	Vague	More obvious	Clear	Obvious
6	Coated paper	Clear	More obvious	Clearer	Obvious
7	Machine-printed invoice	Clear	More obvious	Clearer	Obvious
8	Corrugated wrapping paper	Vague	Not obvious	Clearer	Obvious
9	Facial tissue	Vague	Obvious	Clearer	Obvious
10	Paper cup	N/a	N/a	Clearer	Obvious
11	common cold medicine packaging box	N/a	N/a	Very vague	Not obvious
12	The second page of the courier bill	Clearer	More obvious	Clearer	Obvious
13	Natural toilet paper	N/a	N/a	Clearer	Obvious
14	Floral cloth	N/a	Not obvious	Vague	Obvious
15	Brick	N/a	Obvious	N/a	Obvious
16	Stone	N/a	Not obvious	Vague	Obvious
17	Three plywood	N/a	N/a	Clearer	Obvious
18	Marble	Vague	Obvious	Vague	Obvious
19	White tiles	Vague	More obvious	Vague	Obvious
20	Beige stone	Vague	Obvious	Vague	Obvious
21	Granite	Vague	More obvious	Vague	Obvious
22	Rusty iron rod	Vague	Obvious	Vague	Obvious

4 DISCUSSION

It can be seen from Figures 1 to 3 that the indenedione solution has a better display effect on the biological traces on permeable or semi-permeable objects. For non-permeable objects, such as the outer packaging of Sanjiu cold granules, there is a layer of plastic-like material on the outside. No matter it is directly excited by laser or excited by 445nm or 532nm laser after nindione treatment, a good sweat fingerprint display effect cannot be obtained (as shown in Figure 11).

Due to the characteristics of laser monochromaticity and coherence, the use of laser to excite indenedione can obtain higher fluorescence conversion efficiency. Therefore, the use of laser to excite indenedione has a good fluorescence display effect for many guests (as shown in Figure 1 - 3, 6 - 7, and 12), but because indenedione has a stronger absorption of light around 510nm, so under the irradiation of 532nm laser,

the fluorescence conversion efficiency of indenedione is higher, and the display effect of potential sweat fingerprints is better. (As shown in Figure 5). However, due to the factors of the object itself and other factors, in terms of fingerprint display, although the fluorescence of nindione excited by the 532nm laser is small and high, it is still impossible to obtain clear fingerprint lines, but the fingerprint traces can still be clearly displayed, such as flower cloth, Bricks, stones, granites, etc., although fingerprints with clear lines cannot be obtained for these objects, they can be clearly located for potential sweat fingerprints, which is very convenient for the extraction of biological samples for DNA testing.

The indenedione spray dyeing method is used to treat the samples extracted on the spot, and then use 532nm laser to excite the samples after spraying, which can realize the biological traces on the toilet paper, bricks, stones and other difficult objects. The operation It is convenient and has a very wide range of applications. In the case that clear fingerprint lines cannot be obtained, the positioning of biological traces can be realized, which can greatly improve the efficiency of on-site inspection and physical evidence identification.

5 CONCLUSION

Different lasers produce different fluorescence effects, and there are obvious differences in fluorescence effects produced by different objects. This requires a preliminary understanding and grasp of the type, material composition, structure, *etc*. of the object in the investigation work, and make a preliminary judgment on the laser display effect of potential traces on the object. For the object suitable for direct laser display, select the appropriate laser to achieve the best display effect. When the laser wavelength cannot be determined, you can switch between different wavelengths. To compare the display effect, and finally determine the appropriate laser wavelength.

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Conflicts of interests