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Brief Review of Laser Application in Crime Scene Investigation

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Since the advent of the first ruby pulsed laser in 1960, laser technology has been widely used in various industries such as industrial processing, communications, and medical treatment. In the 1970s, laser technology was introduced into the forensic science field and demonstrated potential fingerprints. It has its unique advantages, and has shown excellent performance in the on-site search and search of biological samples such as blood, semen spots, body fluids, and trace material evidence such as fiber and gunpowder residues. The original laser has low power, large size, poor stability, and high environmental requirements. Its application range is often limited to laboratory environments and cannot be directly applied to crime scene investigations. With the rapid development of science and technology, ND: YAG lasers, semiconductor lasers and other solid-state laser technologies have become more mature and perfect. The output laser wavelength has covered short-wave ultraviolet to infrared wavelengths, and the size and weight of the laser have been greatly reduced. The power, beam quality, etc. have been greatly improved, which has laid a solid foundation for the application of lasers in field surveys. Especially in recent years, the manufacturing process of semiconductor lasers has advanced by leaps and bounds, and the portability of lasers has been further improved, which makes it more convenient for field surveys. Application of laser.

1. CHARACTERISTICS OF LASER

Laser is a coherent light of stimulated radiation. Compared with light sources such as multi-band light sources and incandescent lamps, lasers have a high degree of monochromaticity, directionality and high brightness.

Multi-band light sources are often used in site surveys. Multi-band light sources can output a variety of colors, including purple, blue, green, red, and infrared, and provide higher power. However, lasers are compared with multi-band light sources. There is a significant difference. The light emitted by the multi-wavelength is continuous light, which is an incoherent light source. The light of different wavelength bands output by the multi-wavelength light source has a wide spectral line width, about 40nm, while the laser is a strong coherent light with a very wide spectral line width. Narrow, a few nanometers or even narrower. Although the output power of the multi-band light source is relatively high, the power evenly distributed to each spectral line at the same power is far less than the corresponding power of a single laser spectral line, which makes the laser excitation fluorescent The effect is better than a multi-band light source, especially for some samples with very weak light absorption, the effect of laser excitation of fluorescence is much better than that of a multi-band light source.

The laser has high directivity, and its directivity is much better than that of ordinary light sources. Its divergence angle is very small, much smaller than that of ordinary light sources. The diameter of the laser spot output from the optical resonator is generally small, about It is a few millimeters, which is determined by the mechanism of stimulated radiation and the restriction of the optical resonator on the direction of the beam. It is one of the characteristics of the laser, which determines the high brightness of the laser. The high directivity and small spot size of the laser are often not conducive to the search of

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material evidence at the crime scene, and the high brightness of the laser is the advantage of the laser when it is used in the field investigation. These two aspects of the laser. The characteristics show a certain conflict in the application of on-site investigation. The solution is often to expand the laser beam by adding a divergent lens group under the premise of ensuring the brightness, increase the divergence angle of the laser, and increase the cross-section of the laser spot. However, ordinary light sources have poor directivity, large divergence angle, and very low brightness, and it is often necessary to add a converging lens group to increase the brightness of the output light. Although adding a lens group will change some of the optical characteristics of the laser, the main characteristics of the laser in the field survey are monochromaticity and high brightness. The introduction of the lens group will not have a big impact on these two basic characteristics of the laser.

2. THE METHOD OF LASER DISPLAY OF BIOLOGICAL TRACES

In the process of using lasers to find and search for criminal material evidence at the crime scene, three methods are mainly used, namely the grazing incidence method, the absorption reflection method, and the fluorescence display method. The grazing incidence method uses the grazing incidence method to irradiate the sample, mainly searching for trace materials such as dust footprints, handprints, hair, fibers, and glass fragments. The absorption reflection method uses the difference in absorption of laser light between the sample and the object to show traces. This method requires a significant difference in absorption between the sample and the object. The fluorescence visualization method uses the characteristics of laser monochromaticity and high brightness to excite the fluorescence of the sample or object to realize the visualization of traces.

Compared with multi-band light sources and short-wave ultraviolet light sources, the application of lasers in the grazing incidence method and the absorption reflection method does not have a clear advantage. The multi-band light source can output strong light of each color band. In the grazing incidence method and the absorption reflection method, the multi-band can use different light sources to search. In this regard, the multi-band light source has a greater advantage. The short-wave ultraviolet light source has obvious advantages in the absorption and reflection method, because most substances exhibit strong absorption of short-wave ultraviolet, which can affect some smooth objects such as glass, ceramic tiles and other surfaces, as well as sweat fingerprints on lime-painted walls. It has a good display effect, but it can't get a good display effect when the laser is used for visualization. Short-wave ultraviolet can also excite fluorescence, which can be used to excite the fluorescence of biological samples such as semen. However, due to the limitation of the production process, the short-wave ultraviolet light source used in the field has low power and large divergence angle, which appears in the process of large-area search. It is inadequate, and because of the low brightness, the fluorescence excited by trace substances is very weak, which is not conducive to observation. Because of its monochromaticity and high brightness, laser has obvious advantages in exciting fluorescence, which is unmatched by multi-band light sources and short-wave ultraviolet light sources. The laser is very suitable for searching for biological materials in the field. In the field survey, the wavelength of the laser cannot be adjusted, and the wavelength is single. However, due to the high laser power, some samples with low absorptivity can often excite strong fluorescence under the excitation of high-power lasers.

3. LASER IS USED TO SEARCH FOR BIOLOGICAL MATERIALS ON CRIME SCENE

The role of lasers in field surveys is mainly to search for biological samples, including the search and discovery of traces such as sweat, blood, semen, saliva, and urine spots.

The main component of sweat in the human body is water, the main inorganic substances are sodium chloride and potassium chloride, and the organic components are mainly various amino acids. It also includes organic substances such as urea, non-protein nitrogen, and vitamins. The normal sweat of the human body is mainly water, and organic matter accounts for a small proportion. The fluorescence is often not observed with laser excitation. However, the adhesion characteristics of sweat can be used, and ninhydrin, zinc chloride, etc. can be used to show the residual sweat fingerprints. Laser visualization of the parts of the laser, excited these substances to produce fluorescence, often will achieve good results; and for grease fingerprints, because they contain more organic components, the use of laser excitation will often get a good fluorescence display. For people who regularly take vitamins, the sweat secreted by them tends to contain more vitamins, which will emit strong fluorescence under laser irradiation.

In addition to water, semen and vaginal secretions are mainly organic components of various proteins, amino acids, enzymes, etc. The fluorescence peak of semen is about 622nm. However, in the actual site investigation, the flavin contained in the fine spot makes it fluoresce in white under

ultraviolet light, and the edge of the spot is light blue-purple. Spots of other human secretions, such as sweat spots, urine spots, vaginal secretions, breast milk, nasal mucus, etc., as well as soap, paste spots, certain drugs, chemical fiber products, can also appear similar to sperm spots under ultraviolet light of Fluorescence. The appearance of silver-white fluorescence under ultraviolet light is not a specific reaction of sperm spots and cannot be used as a basis for determining sperm spots. In addition, ultraviolet light causes great damage to human skin and eyes. Excessive application of ultraviolet light on the spot is not recommended. At the same time, the power of ultraviolet light is generally relatively small, and the excitation efficiency for trace material evidence is relatively low. For lasers, lasers in the visible wavelength range can be selected, such as 445nm laser or 532nm laser as the excitation light source. With eye protection, the visible wavelength laser will not cause damage to the human body. The laser's monochromaticity and high brightness, the efficiency of exciting fluorescence is much higher than other light sources, especially for the search of trace residues in body fluids. The laser shows its unique optical characteristics.

Excitation of blood traces with commonly used visible light lasers often fails to obtain the fluorescence effect that can be observed with the naked eye. The human blood is mainly composed of blood cells and plasma, and the corresponding endogenous fluorescent substances are derived from the endogenous porphyrin, tryptophan, reduced nicotine adenine dinucleotide (phosphate) and flavin in the blood. Adenine dinucleotide. The fluorescence excitation efficiency of these substances shows a significant difference with the change of the wavelength of the excitation light. In the visible light band, the excited blood fluorescence is very weak and cannot be directly observed with the naked eye. The use of lasers to search for blood stains at the scene is mainly to search for blood stains on some fabrics with complicated patterns, such as clothes, sheets, sheets, etc. On the one hand, the difference between blood stains and fabric materials is used, and there are differences in the absorption and reflection of lasers. As a result, blood stains are found. On the other hand, the fabric itself tends to emit visible fluorescence under the excitation of the laser, forming a difference between the blood stains and the fabric to realize the positioning of the blood stains.

Fig. 1 Use 445nm laser to visualize traces of fine spots on white furniture

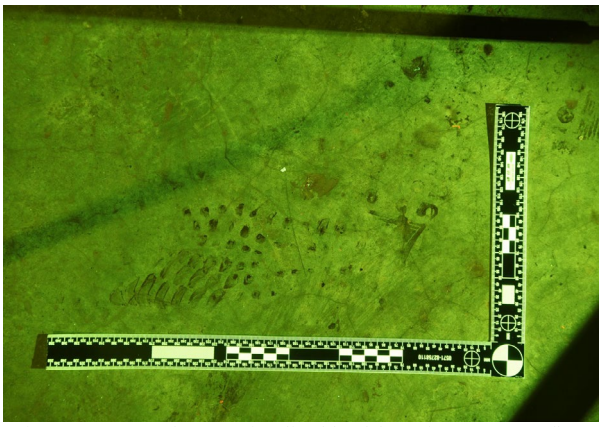

Fig. 2 Use 445nm laser to visualize blood footprint on cement floor

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