

Detection of Fingerprint using He-Ne and Diode Lasers on Aluminium and Glass Surfaces

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Abstract: There are different latent fingerprint recovering techniques, physical and chemical techniques are available for the development of latent fingerprints. Fingerprints detection requires high sensitivity, which is provided by luminescence and appropriate physical and chemical treatments. Photoluminescence detection of latent fingerprints has over the last quarter-century brought about a new level of fingerprint detection sensitivity. Fingerprints have many uses, a chemical solution usually used to detect fingerprints but it takes time. In this paper, we were operating with low-power lasers, He-Ne laser with output power 1mW and wavelength 632.8nm and diode laser with output power 5mW and wavelength 532nm to detect fingerprints on an aluminium and glass surfaces. Fingerprints were exposed by the laser beam through a convex lens with focal length 5mm then a digital camera was used to record luminescence from fingerprint. The revealed results show clear images for the fingerprints using two types of lasers He-Ne and diode and appearing its characteristics on different surfaces obviously. Using laser sources to detect fingerprints is a simple method using low-level lasers without chemicals, in a short period of time, with low cost and gives good results.

Keywords: Forensic Science, Laser-matter Interaction, Laser Luminescence, Latent Fingerprint Detection, Photoluminescence, Optical Sensor

1. Introduction

Significant advances in laser technology and the development of novel light detectors have dramatically improved spectroscopic methods for molecular characterization over the last decade. Lasers with its different spectral region can insert in many applications several among many applications, the use of lasers in optical disk drives, laser printers and engines, barcode scanners and fibre optic in a free-space optical communication, laser surgery and skin treatment, cutting and welding materials; military and law enforcement agencies to identify goals and measure their speed and laser lighting displays in the field of entertainment DNA sequencing tools used to detect fingerprints. [1-4].

When a finger touches a surface, on the order of 0.1 mg of residue is left behind, comprising a latent fingerprint. Typically, 98–99% of this is water, which soon evaporates to

leave behind on the order of a microgram of material, which is made up of, in roughly equal quantities, inorganic salts and a complex mixture of organic constituents, including fatty acids, triglycerides, amino acids, vitamins, squalene, urea, etc. The visualization of latent fingerprints mostly involves targeting a class of these organic components.

Different powders and Small particle reagent (SPR) have been used by various workers for the development of latent fingerprints on different surfaces. [5-11].

Several researchers investigated whether certain fingerprint methods can recover latent fingerprints on glass and metal surfaces submerged in water. [8, 10, 11]

The light sources used to generate narrow bandwidths come in several different varieties, including UV lamps, filtered lamps, and lasers. Each of these light sources has advantages and disadvantages, depending on the intended purpose and one's budget. Recently, "alternate" or "forensic" light sources (filtered lamps) have become heavily relied on

in laboratories and at crime scenes because of improvements in power output, versatility, portability, and affordability when compared to lasers.

In 2006 M. T. TASCHUK et al conducted a preliminary investigation of the capabilities of femtosecond LIBS for detection and mapping of latent fingerprints, and demonstrated its structure using 400nm, $84 \pm 7 \mu\text{J}$ pulses.[12]. Also in 2009, Alaoui used Argon laser with the blue lines 476.5 and 488 nm to excited the prints to be detected and observed the sample's fluorescence is under orange filters. He also compared between photoluminescence fingerprints and trace explosives detection. [13].

In this paper, we have studied visible fluorescence spectra of fingerprints excited with 532 nm and 632 nm illumination in detail with our new imaging system.

2. Materials and Methods

The first laser used to detect the fingerprint was Helium-Neon laser (He-Ne) with wavelength 632.8 nm and output power 1 mW, the second one was green diode laser pointer with wavelength 532nm and output power 5 mW. Convex lens with focal length 5mm was used to defocuses laser and carried out the photoluminescence from the surfaces. A note-3 phone camera with megapixel 13mp and 2160p was used to photo the fingerprint. Two different surfaces were used to detect the fingerprint, the first sample was an aluminium knife with a soft surface, the second surfaces were microscopic slides with clear glass and thickness of 1.0mm-1.2mm and 25×75mm dimensions.

Fingerprints deposited on the two different dry surfaces (aluminium and glass); two impressions were taken from person on the two surfaces; each impression consisted of pressing the pads of the four fingers onto the surface. Surfaces were excited by laser beams with different powers and wavelengths through convex lens, with focal length 5mm. Diode laser (with wavelength 532nm and output power 5mW) and He-Ne laser (with wavelength 632.8nm and output power 1mW) were used for this purpose. The search for luminescence from the samples was undertaken without dyes, then a photo of these fingerprints were recorded by digital mobile phone camera without using a Polaroid, with appropriate angle, see figure 1.

Lasers can generate enough intensity that even incidental or reflected light may damage the unprotected eye; so goggles were weird.

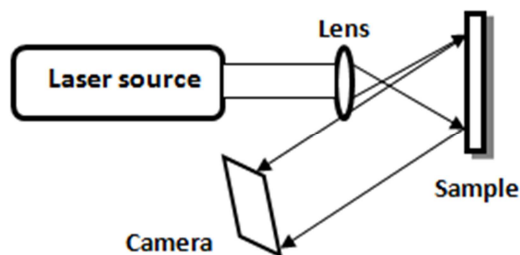


Figure 1. Configuration used to record photographs of luminescent fingerprints; schematic diagram.

3. Results

3.1. Detection of Fingerprint on Aluminium Surface

Figure 2 shows a photo of fingerprint that has been appearing by red laser excitation with low output power 1mW on an aluminium knife surface.

When He-Ne laser with output power of 1mW exposed on aluminium knife surface a fingerprint with six different patterns appears, with the following characteristics:

1. Island.
2. Core.
3. Bridge.
4. Bifurcation.
5. Ending ridge.
6. Crossover.



Figure 2. Fingerprint mark recovery from metal (aluminium) surface by red laser.

Figure 3 shows a photo of another different fingerprint that has been appearing by green laser excitation with low output power 5mW on an aluminium knife surface.

Diode laser pointer with an output power of 5mW used to expose on aluminium knife surface the showing fingerprint with six different following patterns:

1. Island.
2. Core.
3. Bridge.
4. Bifurcation.
5. Ending ridge.
6. Crossover.

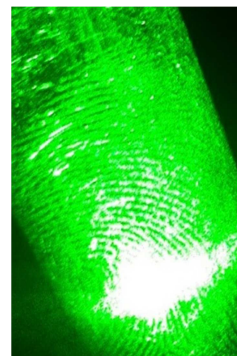


Figure 3. Fingerprint mark recovery from metal (aluminium) surface by green laser.

3.2. Detection of Fingerprint on Glass Surface

Figure 4 shows a photo of fingerprint that has been appearing by laser exposure with power 1mW on a microscopic glass slide surface.

When He-Ne laser with output power of 1mW exposed on microscopic glass slide surface a fingerprint with seven different patterns appears, with the following characteristics:

1. Island.
2. Core.
3. Bridge.
4. Bifurcation.
5. Ending ridge.
6. Crossover.
7. Delta.

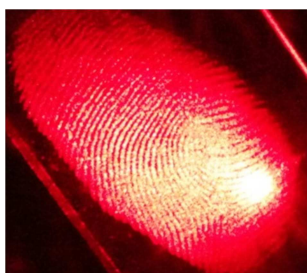


Figure 4. Fingerprint mark recovery from glass surface by red laser.

Figure 5 shows a photo of the same fingerprint that has been appearing by laser exposure with power 5mW on a microscopic glass slide surface.

Diode laser pointer with an output power of 5mW used to expose on microscopic glass surface the showing fingerprint with seven different following patterns:

1. Island.
2. Core.
3. Bridge.
4. Bifurcation.
5. Ending ridge.
6. Crossover.
7. Delta.

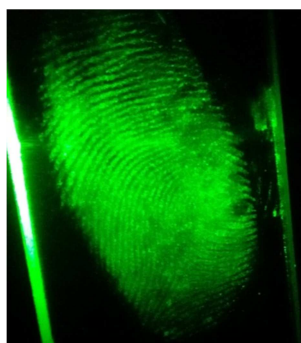


Figure 5. Fingerprint mark recovery from glass surface by green laser.

4. Discussion

Viewing fingerprints under a laser could induce fluorescence prints. The fingerprint fluorescent images on a

metallic surface using red and green laser beams presented in figures 2 and 3, and the fingerprint images on a glass surface using red and green laser beams presented in figures 4 and 5. These images represent approximately 85% of a total thumbprint area of approximately 6cm²; they show a lot of patterns. There is no possibility of unacceptable damage to the fingerprint when imaging it by these visible lasers. Laser-induced fluorescence is generally considered a nondestructive technique. In comparison by using Laser-Induced Breakdown Spectroscopy, small damage will happen to the print to the point that the LIBS measurement process. [12]

Good quality fluorescent images of a latent fingerprint could be successfully imaged using this technique. This simple system has been successful in ablating finger marks on glass and aluminium; it can be applied to detect the fingerprints from the surfaces which it is notoriously difficult to lift fingerprints with results that are better or comparable to traditional methods.

5. Conclusions

In conclusion, fingerprints were shown on the surfaces of aluminium and glass using a He-Ne and diode lasers with output power of 1mW and 5mW respectively, the results revealed a reliable fingerprint signals on different surface materials in a short time, with no damage to the latent fingerprint and less cost than chemical demonstration methods. Further study is expected to study and compare two different visible laser light sources based on portability, cost, sensitivity, and power output.

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