Fingerprint Detection Using Phosphorescent and Fluorescent Phosphors: Opinion

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Abstract

The effective detection of fingerprints is currently crucial for criminal investigations. Fluorescent organic compounds are frequently used to reveal fingerprints, although they are ineffective at finding fingerprints on porous or reflective surfaces. Inorganic phosphors have been used to address the issue of collecting fingerprints on porous/reflective surfaces because they exhibit characteristics such as variable colour emission, afterglow, high chemical stability, and nanosize, which enable the detection of fingerprints on any porous or non-porous surfaces. This review provides a description of how phosphorescent is used as a result of these last two characteristics. The primary physical and chemical aspects of fingerprints that allow for their detection and collecting from any surface were first covered, as well as fluorescent phosphors' use in the detection of latent fingerprints. The main morphological, structural, and luminescent characteristics of fluorescent and phosphorescent phosphors that permit their application for fingerprint detection were then presented. Later, we showed that both fluorescent and phosphorescent phosphors can be used to visualise fingerprints with high resolution and high contrast without interference from the background surface, which is ideal for their collection and registration in the Automated Fingerprint Identification System, using photographs of fingerprints (with and without light emission from the phosphors deposited on them) (AFIS). Depending on the type of surface (porous or non-porous, reflecting or not reflective), where the fingerprint is deposited, we think that this review may be helpful in understanding how to choose an appropriate phosphorescent or fluorescent material for fingerprint detection.

Keywords: Latent fingerprint • Persistent phosphorsn • Fluorescence • Fingerprint identification

Introduction

High-tech biometrics have recently become popular due to the growing desire for enhanced personal data protection. Recently, personal access to buildings or computer systems has been enabled by physical characteristics like fingerprints, voice, face, or retina. Systems on the internet have been combined with biometrics to enable safer bank transactions, data collection, and identification verification in airports. Forensics and computer security also depend on biometrics for mobile applications. The most common biometric method for personal identification is the detection and comparison of fingerprints because of their distinctiveness, permanence, universality, high collectability, and good storability. In order to give access to data, fingerprint technology is now used in banks, tax collection offices, and laboratories. Fingerprint recognition is also used to get access to computer and mobile devices. Thus, it is becoming more usual for devices used every day to identify fingerprints. The recognition of fingerprints is also employed in criminal case investigations because it might establish a suspect's guilt or innocence. The fingerprints of suspects or offenders have been kept on paper or on plastic cards over the course of several decades using ink, a slab, or a roller. Normally, the fingerprints on the surfaces are invisible to the human eye. Occasionally, they can be seen based on how much dust or grease has accumulated in the fingerprint. By using luminous powders, it is possible to view fingerprints that have been left behind by clean hands on surfaces that are very difficult to see with the human eye. a conventional method for utilising luminous powders to expose latent fingerprints. When pressing a finger on any surface in the initial phase, the pressure used should be very light in order to mimic a fingerprint that was accidentally left on the surface.

The luminous powder is then manually applied on the latent fingerprint in step two. and the extra powder is brushed away, revealing more of the fingerprint's characteristics to the unaided eye. More fingerprint features may be retained on the tape if the tape is removed properly. A strong light emission from the powder put on the fingerprint will be visible if it remains on the surface after being activated by UV light. In order to capture high-quality details at this moment, a photo should be shot with a high-resolution camera. This picture will then be compared to other acquired fingerprints that are already recorded in a database. An individual can be recognised in this way. The population of major cities has increased dramatically, which has led to a rise in crime and the quantity of fingerprints gathered. Their manual search and registration consequently got difficult. The Automated Fingerprint Identification System (AFIS) was developed to make fingerprint comparison and search easier. AFIS is a computer programme designed to make it easier to save, find, and match fingerprints by scanning fingerprint cards from sophisticated databases. Before being registered in the AFIS systems, the fingerprints must exhibit the following characteristics: Sharpness: The fingerprint must have multiple distinguishing features (such as arcs, loops, and whorls) and should be visible to the unaided eye.

Contrast: To distinguish between the fingerprints' forms and the surface where they were collected, there must be a strong contrast. Size: The primary fingerprint features, such as arcs, loops, and whorls, should be large enough to be seen in photographs. The fundamental ridges that give each fingerprint its individuality. Every individual has a distinct pattern in their fingerprints that makes it possible to distinguish them from other people; even identical twins have distinctive ridge patterns. The kind of surface on which the fingerprints are "printed" affects how easy or difficult it is to discover them. The porosity, smoothness, and softness of the surface where fingerprints are deposited, as well as whether they are visible or not, have all been taken into consideration by analysts when dividing fingerprints into two categories. The last fingerprints are the ones that forensic scientists are most interested in and are known as latent fingerprints.

The visible fingerprints are known as patent fingerprints. Rough surfaces present the biggest challenge for fingerprint recognition and collecting. On flat surfaces, however, fingerprint detection is simple. Iodine fuming, iodine spray reagent, ninhydrin, and 1,8-diazafluoren-9-one are some revealing substances used to detect the latent fingerprint of porous surfaces. Silver nitrate is also frequently used to detect latent fingerprints because it combines with the elements of sebaceous sweat to create a silver-gray deposit that is visible to the naked eye. Silver nitrate fuming, powders, and cyanoacrylate fuming can all find latent fingerprints on smooth surfaces. Metal powders including aluminium, carbon, brass, and fluorescent organic powders are frequently used to identify fingerprints. Fluorescein is one of the classic organic fluorescent dyes used to detect fingerprints. According to their emission mechanisms, luminous materials can also be categorised. The term "downconversion phosphors" refers to materials that are excited by high-energy photons (UV wavelengths) and produce lower-energy photons (visible light). A substance is referred to as an upconversion phosphor if it is activated by low energy photons (such as infrared light) and produces high energy photons (such as UV or visible light) as a byproduct. In the upconversion (UC) mechanism, light at wavelengths shorter than the excitation wavelength is emitted as a result of the sequential absorption of two or more photons. We should point out that persistent (phosphorescent) phosphors can be utilised for fingerprint detection, but this is not a common application for them; instead, they are typically used in lighting or bioimaging.

For this reason, we provide in this overview the most recent developments in the identification of fingerprints using inorganic phosphorescent materials. Compared to inorganic phosphorescent materials, the literature on the application of inorganic fluorescent materials for fingerprint detection is far more extensive. Therefore, we only included in this review works that were published recently and/or were pertinent to the topic of using inorganic fluorescent materials to identify fingerprints. We examined how the morphological, structural, and luminous characteristics of the phosphorescent materials were helpful for the detection of fingerprints on various surfaces, such as wood, metal, paper, and plastic, in the first section. In the second section, we discussed the luminous materials' same qualities and clarified how effectively they could detect fingerprints on the aforementioned surfaces. In the third section, we explore the advantages of phosphorescent materials over fluorescent materials (or vice versa) for fingerprint detection and compare how well they function for fingerprint identification on various surfaces. In the fourth segment, we finally covered the existing restrictions on the usage of phosphorescent/fluorescent phosphors for fingerprint identification.

Conclusions

For the purpose of detecting fingerprints, fluorescent phosphors are preferable to phosphorescent materials because they produce images with higher contrast, clarity, and quality that can be stored in the AFIS system. Aluminum foil, glass, and polymeric surfaces are among the surfaces where fingerprints can be more easily seen when using phosphorescent materials. Additionally, some phosphorescent materials, such as ZnO/SiO2, can be used to detect fingerprints on sticky surfaces, something that fluorescent materials cannot do. Some fluorescent surfaces that include the fingerprint can produce light when UV stimulation is applied. There are two methods available to isolate the fingerprint from background light interference: A persistent phosphor can be activated and deposited on a fingerprint. A fluorescent substance can be applied on the fingerprint and then activated with NIR light; the fingerprint will then emit visible emission, which will enable its collection. ii) The fingerprint can then be visualised for collection after being exposed to UV light for several minutes. Because fluorescent materials produce more brightness and contrast, option "ii" is generally preferable. The use of fluorescent pigments to expose fingerprints on imprinted or surfaces with patterns. The greatest options for this are the upconversion materials. considering that their excitation wavelength won't result in emission from the background, which fluorescent technologies based on Eu ions cannot eliminate because they require UV light to create red emission and This will result in background emission. Additionally, the articles the results of this review showed that the amount of emissions produced by The organic makeup of fingerprints has no impact on the fluorescent phosphors that have been put on them. It's important to note that the The latent fingerprint's lipids and water are evaporating with time, which would result in the original fingerprint being altered, and it could have a different appearance following a fresh fluorescent phosphor detection. Due to this, new fluorescent phosphors that can prevent deterioration have been developed. a fingerprint are required. This would enhance the maintenance of even after its registration in the database for several years, the original fingerprint the AFIS program. The review's materials are excellent candidates for use in criminal justice. scenes. Depending on the scene's circumstances, certain elements could be more effective than others at detecting fingerprints. some circumstances thatThe colour, reflectivity, and roughness of the surface should all be taken into account when selecting a suitable material for fingerprint detection. porosity, substance, and the presence or absence of patterns. the application of novel fluorescent and phosphorescent materials for over the past ten years, fingerprint detection has attracted interest from legal sciences. However, as all of the prior research showed that the visualisation of the fingerprint became dimmer with time even while the phosphors are still on it, materials that can be put on fingerprints without creating their degradation are still needed. The usage of phosphorescent materials is not covered in a lot of literature. phosphors for fingerprint detecting; further study is required to advance their luminescence duration, brightness, functionalization, etc. to be competitive with fluorescent materials sold commercially.

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