INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2021-2022

COURSE: M.Sc. Forensic Science (Questioned Documents, Fingerprints and Forensic Physics)

SEMESTER: III

SUBJECT: PSFSQ302-Advanced Fingerprint Technology-I

TOPIC FOR PRESENTATION: Fingerprint development on challenging surfaces (adhesive tape and skin)

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Introduction

Latent fingerprint are one of the most commonly encountered types of physical evidence at the scene of crime. Development of the latent prints depends upon various factors including the surface on which the print is present.

Fingerprint development on adhesive tape

One such surface which is of great importance and is equally challenging is adhesive tapes. Chances of latent fingerprint being left on adhesive tapes increases due to its sticky surface with which one may come in contact inadvertently. Adhesive tapes can present problem in the processing and development of the latent fingerprint because of multiple reasons. The major reasons include:

- Multiple variety of adhesive tapes available in the market.
- Most tapes needs to be separated from the substrate with which it can be attached like paper, cardboard or plastics. This requires proper separation strategy for removal of the tape from the attached substrate.
- Regular powder gets attached to the entire surface and the background interference is high. fuming techniques too fail to produce clear contrast between the background and the print

Separation methods

Before proceeding with the development technique, the adhesive tape first needs to be removed from the attached substrate. Different methods can be used for this purpose depending upon the nature of the substrate and other conditions associated with the case in hand. The tape separation methods includes:

Peeling off: this method is found to be effective only in some cases. In majority of the cases it tends to destroy the adhesive material and the print as well. When the tape is stuck on a glass surface then peeling the tape can be easier.

Freezing: a conventional freezer or a freezer spray can be used in this method of tape separation. The tape is kept in freezer or freezer spray is used which loosens the hold of the tape on the material followed by which a tweezer can be used to separate the tape. This method is found effective when the adhesive tape is stuck on plastic surface.

Liquid nitrogen: Bergeron reported the success and failure of this method for separation of different types and brands of tapes from various surface. Successful separation was even achieved when the tape was stuck adhesive side to adhesive side. Bailey and Crane reported on the use of a cryogun to facilitate the separation of duct tape. Caution should be taken when using liquid nitrogen since its extremely cold temperature (approximately −195.79°C) can cause frostbite and burns within seconds of contact with skin.

Heating method: the substrate along with the attached tape can be heated to help in separation of the adhesive. This method needs to be used carefully because direct heating can cause potential damage to the adhesive and the print as well. Hair dryer was reported to be useful by Campbell in separation of different tapes from the background. The applied heat facilitated the softening of adhesive followed by which tweezer was used for slowly removing the tape.

Chemical methods: drop wise application of Shandon solvent mixed with 5% chloroform is one chemical method for separation of the adhesive tape. 1:2 mixture of cyclohexane and isopropanol is another chemical used for separation of tape from each other and from paper as well. Un-du was invented by Chuck Foley in 1996. This hydrocarbon based adhesive remover has proved to be helpful for separation of tapes from paper envelops as well.

Processing the adhesive side

1. **Dye stain method: Gentian Violet**

Italian police in late 1960s reported the use of gentian violet for the development of fingerprints of sticky side of tapes. Water-soluble, adhesive-type tapes should not be processed by this method.
Theory: The exact mechanism by which Gentian Violet selectively dyes the lipid constituents of fingermarks is not known, nor has it been determined conclusively, which individual constituents are targeted by the dye. Gurr (1965) proposed that the basic groups of neutral dyes could form a chemical union with the acidic group of the lipids being stained. Preferential solubility of the dye in the lipids may also occur.
Equipment - Scales, beakers, magnetic stirrer and stirring bar, glass tray, clear or dark storage bottles
Materials and Chemicals- Gentian violet solution (Gentian violet 1 g mixed with 1000mL Distilled water)
Processing Procedure- Gentian violet is applied by dipping or spraying. When processing, place the specimen(s) in the gentian violet solution for approximately 1 to 2 minutes, then rinse with cold tap water. The gentian violet solution can be reused.
Violet color fingerprint is developed which can be further photographed.

When the developed print in light then the reagent can be sprayed on the tape more than once. It can at times result in overdevelopment and the background can become violet as well. 10% hydrochloric acid solution can be helpful in controlling background development. However care needs to be taken so avoid the acid from destroying the developed ridge pattern. The carcinogenic potential of the chemical has raised health and safety concerns about its use. Gentian violet was also reported to exhibit fluorescence in the near infrared, when excited with light from the blue-green region of the electromagnetic spectrum (~400–600 nm).

2. **Powder methods**

Powder suspension techniques are now becoming a more common approach to processing the adhesive side of tapes.

Sticky side powder:

Sticky powder was proposed as another option to develop fingerprints on the sticky side of adhesive tapes and was claimed to be more effective in terms of ease of application. A further study comparing the efficiency of Gentian Violet and Sticky side powder to develop prints on the sticky side of tapes concluded that the sticky side powder was more efficient and sensitive but another study contradicted the results and concluded that the phenol-based formulation of gentian violet can give better results.
Equipment - Petri or shallow dish, camel-hair or small brush
Theory - The exact mechanism for development of marks using powder suspensions is unknown, and studies to establish which factors are most important in determining selective deposition are continuing. However, it is thought that the development process is very similar with that for small particle reagent, where micelles or a more random layer of surfactant is formed around the particles. Some component or property of the latent fingermark destabilises these micelles, causing the particulates to deposit preferentially on the ridges.
Materials and Chemicals –

- Sticky-side powder
- Photo-Flo™ 200 solution

Mixing Procedure- Sticky-side powder .... 1 tsp

Photo-Flo™ 200 solution

Place the sticky-side powder in a petri or shallow dish. Photo-Flo™ 200 must be diluted with distilled water by 50% to make Photo-Flo™ 100. Add Photo-Flo™ 100 solution to the powder and stir until mixture is the consistency of thin paint.

Processing Procedure - The solution is painted on the adhesive surface of the tape with a camel-hair or small brush. Allow to set for 30 to 60 seconds, then rinse off the solution with a slow stream of cold tap water. Allow to dry. Repeat procedure if necessary.

Alternate black powder:

Bratton et al. (1996) described a modified version of Sticky-side Powder™ that contained tap water, Liqui-Nox glassware detergent, and black powder (Lightning Powder). This reagent was found to produce the best results on adhesive tape surfaces when compared to gentian violet, ninhydrin, Sticky-side Powder™, cyanoacrylate fuming, and cyanoacrylate fuming with a fluorescent dye stain.

Alternate black powder is used to process the sticky side of adhesive tapes and labels for latent prints.

Equipment - Petri or shallow dish, camel-hair or small brush

Materials and Chemicals –

- Lightning® black powder
- Liqui-Nox™ — concentrated liquid detergent

Mixing Procedure - Lightning® black powder... 1 tsp

Liqui-Nox™ solution (diluted 50:50 with water) .... 40 drops

Combine the Lightning® black powder and Liqui-Nox™ solution in a petri or shallow dish and stir until the solution has the consistency of shaving cream.

Processing Procedure - The solution is painted on the adhesive surface of the tape with a camel-hair or small brush. Allow to set for 30 to 60 seconds, then rinse off the solution with a slow stream of cold tap water. Allow to dry. Repeat the procedure if necessary

Ash grey powder:

Martin reported on the use of ash grey and white powders to develop an identifiable print on black electrical tape used to bind a homicide victim. Ash gray powder is used to process the sticky side of adhesive tapes and labels for latent prints. This method is particularly useful on dark-colored and black tape.

Equipment - Petri or shallow dish, camel-hair or small brush

Materials and Chemicals –

- Ash gray powder
- Photo-Flo™ 200 or Photo-Flo™ 600 solution

Mixing Procedure –

Ash gray powder ....1 tsp

Photo-Flo™ 200 or Photo-Flo™ 600 solution

Place the ash gray powder in a petri or shallow dish. Add Photo-Flo™ solution to the powder and stir until mixture is the consistency of thin paint.

Processing Procedure - The solution is painted on the adhesive surface of the tape with a camel-hair or small brush. Allow to set for 30 to 60 seconds, then rinse off the solution with a slow stream of cold tap water. Allow to dry. Repeat procedure if necessary

3. **Fuming method**

The use of cyanoacrylate fuming of the item to which the adhesive tape is attached has since long been a point of debate. Some researchers suggest the fuming of the items before using the powder suspension method for the development of latent fingerprint.

Sampson claims that fuming with cyanoacrylate helps in stabilization of the latent print on both side of the tape which can be further developed using the powder suspension method. Some other researchers claim that fuming prior the use of powder suspension results in making the powder suspension method incapable of developing the latent fingerprint.

Schiemer et al. performed a study involving five different brands of black electrical tape wherein different techniques for the development of fingerprint on the tapes was performed. The findings of the study suggested sequential treatment of the tape starting from cyanoacrylate fuming followed by staining with a combined BY40/BR28 fluorescent dye stain and the final method was using white powder suspension.

In the 1970s, the effectiveness of fuming iodine and osmic acid to develop prints on tapes was reported by Smith. A subsequent evaluation of iodine fuming by Midkiff et al. found that good results were achieved with fresh prints on clear and light-colored tapes. Poor results were obtained with cloth, paper, or plastic tapes. Darker and more stable prints were obtained when iodine fuming was followed by application of a 7,8-benzoflavone staining solution.

Processing the non adhesive side

For visualization of the latent prints on the non adhesive side of the tape the technique of cyanoacrylate fuming along with fluorescent dye stain can be used effectively. In a research study Berg showed that cyanoacrylate fuming followed by addition of rhodamine 6G in methanol in drop wise fashion can produce florescent print on the non adhesive side of the duct tape. While using this method for processing care needs to be taken that the cyanoacrylate fuming does not interfere with the adhesive side of the tape since that can damage potential print of the sticky side. For protection of the sticky side the tape can be placed on a silicon release paper then the fuming process can be carried out.

The HOSDB noted that carbon-based powder suspensions are more effective on the nonadhesive side of tapes than iron-based powder suspension formulas. Sticky-side Powder™ was also reported to occasionally develop prints on the nonadhesive side of tape. The HOSDB recommended the use of vacuum metal deposition for the nonadhesive side of masking tapes. A silver-only variation of the vacuum metal technique was reported to successfully develop prints on both sides of adhesive tapes. For other types of tapes, the HOSDB recommend the use of cyanoacrylate fuming followed by dye staining and powder suspensions for items that have not been wet. For tapes that have been exposed to water, powder suspension reagents should be used.

(**Home Office Scientific Development Branch** (HOSDB), now the Centre for Applied Science and Technology (CAST))

Fingerprint development on Skin

Developing identifiable latent prints on human skin has always been a source of frustration for the latent print examiner. It is recognized that skin, unlike most surfaces examined for the presence of latent prints, is extremely difficult to develop latent prints on. Skin is the largest organ of the human body. It is composed of tissue that grows and constantly renews itself is pliable, which allows movement, it regulates body temperature and it excretes waste matter. In addition to these constant changes, skin of assault or homicide victims is subjected to many harsh conditions such as mutilation, body fluids, the elements and decomposition after death. Because of the difficulties and lack of success, only a very few cases in which latent prints have been developed and/or identified have ever been recorded. This is the primary reason why very little research has ever been done and only a handful of cases have been solved by the development of latent prints on skin

1 . Iodine silver plate transfer:

The iodine silver plate transfer method for development of latent prints was introduced by Dr. John McMorris in 1936. The use of the technique for skin surface was suggested by Foley. Other resercahers who worked on this method includes Mooney who talked about the purity of silver required in the process. Feldman et al. used iodine fuming followed by leuco crystal for lifting the print on live skin.

Process: The process involved fuming an area of skin with iodine vapor until an impression was visible. After waiting 10–20 s, a polished silver plate was placed in contact with the impression for 15 s. This contact produces ridge detail that is composed of silver iodide. The plate was then exposed to an intense light source to break down the silver iodide, converting it to a dark silver, reverse-image impression.

Theory: Iodine is capable of a range of interactions with different fingermark constituents. One suggestion is that iodine can undergo a reversible addition reaction across the carbon double bonds in the unsaturated fatty acid components of the fingermark residue (Olsen, 1975). This is supported by studies on individual constituents associated with sebaceous sweat (Chu, 2011) that show strong absorption of iodine by the unsaturated squalene constituent and considerably less interaction with the saturated fatty acids. Another suggestion is that iodine vapors gets retained by the moisture present in the latent fingerprints. The iodine in both the mechanism further reacts chemically with silver to form silver iodide that subsequently darkens when subjected to strong light resulting in developed fingerprint.

Exposure of living persons to iodine fumes can cause skin irritation, excessive tears, breathlessness, headache, and can also become a reason of allergic reactions, needing immediate medical intervention.

2. Electronography:

Graham and Gray first reported the use of electronography and auto-electronography to recover latent prints from skin in 1966.

Procedure: The technique first involved carefully dusting the skin surface with a metallic powder. Lead is typically chosen because of the large number of highly energetic electrons ejected after exposure to hard x-rays in the 5–30 kV range. Although iron has a lower electron emission density, it has the advantage of producing lower background interferences. Cunn reported that bismuth powder and a mixture of lead and iron powders could also be used but found the results to be poor.

Emission of radiation from the lead powder can be captured on a photographic film emulsion. The silver halides present in the film are darkened by the radiation and can produce an image of ridge detail present on the skin surface. In order to obtain a proper image, the emitted radiation must be filtered to remove longer wavelengths that can fog the photographic emulsion. This is accomplished by using separate copper and aluminum filters. A Thoraeus filter (composed of separate tin, copper, and aluminum filters) acts to absorb any emitted or scattered radiation from extraneous sources.

For irregularly shaped objects, like a human limb, Graham recommended using a sphygmomanometer (i.e., the cuff from a blood pressure meter) to form a light-tight seal around the limb, filters, and recording film. The x-ray beam is sufficiently strong enough to pass through the cuff and image the print detail. Print-bearing skin can also be removed and imaged in the conventional manner. Prints on cadaver skin were obtained up to 48 h after deposition, when the body remained at room temperature. The author also reported the recovery of a print after 41 h of exposure to rain and sunshine.

Practical limitations: The primary issue is the health and safety issues associated with using finely powdered lead and x-ray radiation. As described by Graham, the technique requires bulky equipment in a laboratory environment. However, Winstanley described the use of portable x-ray generating equipment and a specially designed film cassette that could be used at a crime scene. Several authors report varying results using this technique.

3. Powder method:

The use of magnetic powder to dust for latent prints on live subjects was reported by Gutierrez in 1976. Compressed air was used to remove excess powder from the skin surface. Hammer recommended the use of magnetic powder followed by lifting with a white plastic/foil-like material called Dakty foil. The initial application removed excess powder and sweat. Subsequent lifts were often of superior quality. Detection limits of up to 30 min on live skin and 6 h on cadaver skin were reported.

Melis described the use of direct dusting with magnetic powder to obtain three prints on a female victim after the Kromekote lifting technique failed to produce any ridge detail. The prints were photographed and lifted. There was sufficient ridge detail to make an identification to a suspect in the case. A similar result was reported in Ontario, Canada, by Haslett. Two impressions were developed on the victim’s inner knee and thigh area by direct dusting with magnetic powder. Black and white photographs of the impressions were unsuitable for comparison purposes. However, color photographs taken of the impressions contained sufficient detail to make an identification of a suspect.

A report issued in 2001 by the German Bundeskriminalamt recommended the use of magnetic powder. Approximately 30% of test prints placed on 20 cadavers were recovered using this method. Iodine fuming was used to locate prints, but the method did not produce useful ridge detail. The best method found for lifting the magnetic powder-developed prints was the use of a silicone-based casting material called Isomark®. It was found to lift more powder than gelatin sheets. The skin temperature was maintained at or below 22°C while the ambient temperature did not exceed 27°C. Best results were achieved when the skin surface temperature ranged from 10°C to 15°C. Färber et al. compared the effectiveness of standard and magnetic black powders. In the study, 18.4% of prints developed with magnetic powder were classified as elimination or identification, compared to 13.6% of prints developed with standard powder. The authors recommended a combination of magnetic powder and Isomark for visualizing and lifting prints from skin. Trapecar reported on the use of Swedish Soot powder to successfully recover latent prints (1–4 h old) from live skin. Several different lifting methods were able to record the powder-developed prints (e.g., black and white gel lifters, silicone, transparent adhesive tape).

Menzel reported on the use of fluorescent powders followed by laser examination to reveal prints on skin. Although no inherent fluorescent prints were observed, dusting with Mars Red and rhodamine 6G did produce ridge detail. Direct heating of rhodamine 6G to form a vapor was also found to develop prints.

4. Cyanoacrylate fuming

Hamilton and DiBattista described the use of cyanoacrylate, accelerated by using sodium hydroxide, to successfully recover an identifiable print from the skin surface of a 5 year old victim. Gray magnetic powder was used after fuming and the print was subsequently transferred using frosted lifting tape. Ridge detail on the lifted impression was only visible when a light source was placed at a 50° angle. Delmas described a sequence involving the use of a laser (for inherent fluorescence), followed by cyanoacrylate fuming, and black magnetic powder mixed with rhodamine 6G. A 5 W argon ion laser was used to illuminate the powder-developed prints. A modified cyanoacrylate method was reported by Jian and Dao-An. The technique involved coating neutral filter paper with a cyanoacrylate-ether solution. After drying, the filter paper sheets were placed onto the skin surface for 5–60 min. Test prints on live skin were developed up to 36 h and up to several days on cadavers. Hebrard and Donche noted that cyanoacrylate fuming results were better on a warm skin compared to a body that had been in a cold room.

Misner et al. reported on the use of a technique based on cyanoacrylate fuming followed by staining with thenoyl europium chelate (TEC). The cyanoacrylate fuming was done at room temperature at the lowest effective relative humidity level (in this case 66% was recommended). The TEC solution was poured over the developed cyanoacrylate polymer, allowed to dry, and then rinsed. The presence of methyl ethyl ketone in the stain solution was found to be critical, as it aids the incorporation of TEC into the polymer fibers. The dye stain was excited with long-wave ultraviolet radiation and the maximum emission occurred at 614 nm (no filter is required).

5. Iodine-Naphthoflavone

Wilkinson et al. investigated the use of iodine followed by α-naphthoflavone (also known as 7,8-benzoflavone) for developing prints on skin [223]. The technique was compared to cyanoacrylate fuming-TEC staining, RTX fuming, magnetic powder, and iodine-silver plate transfer. The α-naphthoflavone was dissolved in a 1:9 mixture of chloroform and cyclohexane and applied using either a wash bottle or an aerosol sprayer. The iodine/α-naphthoflavone technique was found to produce the most consistent results, although the prints developed by this method were relatively fresh (up to several hours). The skin temperature measured at the time of latent print deposition ranged from 14.5°C to 32°C. In one instance, a body at 30°C produced excellent quality ridge detail after cyanoacrylate fuming and TEC dye staining; however, in another instance where the body temperature ranged from 16°C to 30°C, test prints were not recovered using the same procedure.

6. Direct lifting methods

In 1978, Reichardt et al. recommended the use of the Kromekote lifting technique as an alternative to iodine-silver plate processing. A latent fingerprint on human skin may be lifted prior to developing by firmly pressing the Kromekote card, an 80- pound high gloss paper to the surface for 2 to 3 seconds. Lifting of the card should be done carefully to prevent slippage, and should be completed with a continuous motion until entirely free of the skin surface. Then the Kromekote card is processed with black fingerprint powder using fiberglass brush, to develop the latent impression. The print will be a mirror image of the actual fingerprint, and it should be photographed and reversed to avoid confusion. Irregularities in the skin surface may require the use of silicone rubber casts to lift the developed print.

The kromekard technique is capable of lifting prints from living victims for up to 1 1/2 hours after the print was placed. Cosmetic oil and lotions seriously affect the retention of latent fingerprint impressions. On deceased victims, the fingerprint examination should be done before the body is refrigerated. The undersides of the biceps, sides of the torso, the neck, and the tops of the feet most successfully yield latent impressions. The Kromekote lift technique may be repeated several times on the same impression without apparent damage to the print. Stretching of elastic skin will provide best results. In cases where the skin surface has been immersed in water, air drying may permit the lifting of sebaceous prints even for immersion periods of more than 30 minutes. The technique was tried by

Forensic Identification Unit (FIU), Vancouver Police Department in 2005, to recover latents from upper arms of homicide victim, but the technique failed to yield print activity.

Sampson reported on the use of glass as a transfer medium [200]. While using this method, a test latent print placed on live skin was lifted using a glass plate. The glass plates were then fumed with cyanoacrylate, dusted with magnetic powder, and then transferred using lifting tape onto a suitable background. The best results were observed when the glass plates were maintained at approximately 21°C (70°F).

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INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2021-2022

COURSE: M.Sc. FORENSIC SCIENCE (QUESTIONED DOCUMENTS, FINGERPRINTS AND FORENSIC PHYSICS)

SEMESTER: lll

SUBJECT: ADVANCED FINGERPRINT TECHNOLOGY - I

TOPIC FOR PRESENTATION: CBRNE

PRESENTED BY: PRIYANKA BASUTKAR

ROLL NO: 02

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CBRNE

INTRODUCTION

The release into a crowded Tokyo subway car of a highly toxic nerve agent by the Japanese religious doomsday sect, The Aum Shinrikyo, in 1995 resulted in 12 deaths and about 5500 persons seeking medical treatment [50]. This attack illustrated the type of modern day terrorist threat that no government could ignore. Many government agencies created chemical, biological, radiological, nuclear, and explosive (CBRNE) response teams as part of a CBRNE event management strategy. These response teams are multidisciplinary, comprised of numerous individuals with varied and specialized knowledge who are responsible for mitigating and investigating such an event. Peace Officers such as explosive disposal specialists and forensic identification specialists would typically be members in a CBRNE response team, tasked with explosive mitigation and crime scene examination, respectively. Scientists and public health officials are also part of the CBRNE response team to provide the expertise and equipment required to identify chemical, biological, or radiological agents and to manage safely the ensuing public health crisis.

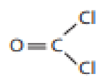
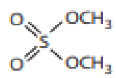
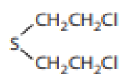
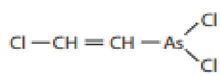
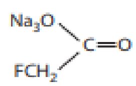
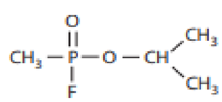
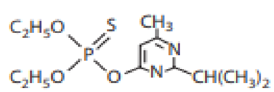
The distribution of letters containing viable *Bacillis anthracis* spores throughout the United States Postal Service in October 2001 demonstrated a lack of interoperability between the public health and the law enforcement sectors [51] and further heightened public concern toward chemical and biological terrorism. Consequently, CBRNE response teams are now better trained, frequently participating in multiagency exercises designed to practice the protocols for sampling and analysis of both the agent and the physical evidence that may help to identify the perpetrators. Scientific staff within law enforcement agencies have worked hard to understand how the presence of chemical and biological warfare agents, as well as the decontamination agents used to neutralize them, will affect the performance of chemicals used to enhance friction ridge and footwear impression evidence.

CHEMICAL CONTAMINATION

Chemical warfare (CW) agents can be utilized by small groups of disaffected citizens who have no significant funding or expert knowledge. In today's Internet world, numerous websites provide detailed descriptions on how to manufacture CW agents. Several precursors have common industrial applications and could easily be obtained by determined groups. The utility of chemicals for terrorist activity by independent groups includes consideration of several criteria such as toxicity, quantities required, ease of acquisition, ease of transportation, and ease of dissemination. The chemical structures of selected CW agents are shown in the following Table and include examples of the different categories of CW agents (i.e., irritants, blister, blood, choking, and nerve agents). This categorization of CW agents is based on the effect of the chemical on the human body.

Nerve agents are particularly toxic and are further subdivided; the G-series was developed in the 1930s and because absorption occurs through the skin and respiratory tract (e.g., sarin) they are more lethal and faster acting than mustard gas; the V-series, developed in the 1950s, are even more toxic and persistent than the G-series (e.g., VX); and binary agents.

Chemical Structures for Selected Chemical Warfare Agents

Chemical Warfare Agent	Chemical Structure	Agent Type
Hydrogen cyanide	H − C ≡ N	Blood
Phosgene		Choking
Chlorine	Cl − Cl	Choking
Dimethyl sulfate		Blister
Sulfur mustard		Blister
Lewisite I		Blister
Sodium fluoroacetate		Irritant
Sarin		Nerve
Diazinon®		Irritant

The reactive components within friction ridge residues commonly used to detect friction ridge impressions are amino acids, lipids, and in the case of blood-contaminated latent impressions, heme proteins. Structures of CW agents suggest that some CW agents would react with the functional groups in friction ridge residues, and latent friction ridges that have been exposed to such agents might show reduced detection rates. It is also possible that the CW agents might display reactivity toward the chemicals used for friction ridge detection.

In 2005, a study was published that described the effects of nine CW agents, including at least one example of each type of agent (e.g., blister, blood, choking, irritant, and nerve), on the detection of friction ridge impressions using common development methods. Due to the difficulty of removing contaminated evidence from CBRNE-contaminated crime scenes, the researchers considered only portable techniques that offered good performance on a wide variety of substrates. The following friction ridge reagents were studied: DFO, ninhydrin, CA/BY40, chemist gray powder, magna black powder, gentian violet, chemist gray/Photo-Flo, amido black, Hungarian Red, and leucomalachite green. Friction ridge impressions on paper, plastic, glass, metal, wax cartons, electrical tape, masking tape, and blood impressions on linoleum were aged for 1, 7, and 14 days prior to exposure to CW agents.

Once exposed, the friction ridge impressions were detected immediately or after periods of 24 and 48h. Performance was compared to a control set of aged friction ridge impressions created under identical circumstances, but not exposed to CW agents. The control set was developed 24h after the experiment had begun. For CW agents that could be dispersed as either liquid or vapor, both exposure methods were tested. As the time between exposure to CW agents and friction ridge development increased, fewer identifiable latent friction ridge impressions were recovered relative to the control set. When used for hydrogen cyanide–contaminated nonporous evidence, the fluorescent technique CA/ BY40 developed more identifiable latent friction ridge impressions compared to powder. DFO also developed more friction ridge impressions when used for hydrogen cyanide–, sarin–, or sodium fluoroacetate–contaminated porous evidence compared to ninhydrin. Whether these results offer a significant advantage to warrant the use of fluorescent techniques for the examination of a chemically hazardous crime scene, given the fatigue factor of performing this type of examination as well as the logistics of using forensic light sources in a contaminated scene, must be decided by CBRNE-trained crime scene examiners. Contamination of friction ridge impressions with liquid microdroplets was found to be highly destructive compared to vapor exposure.

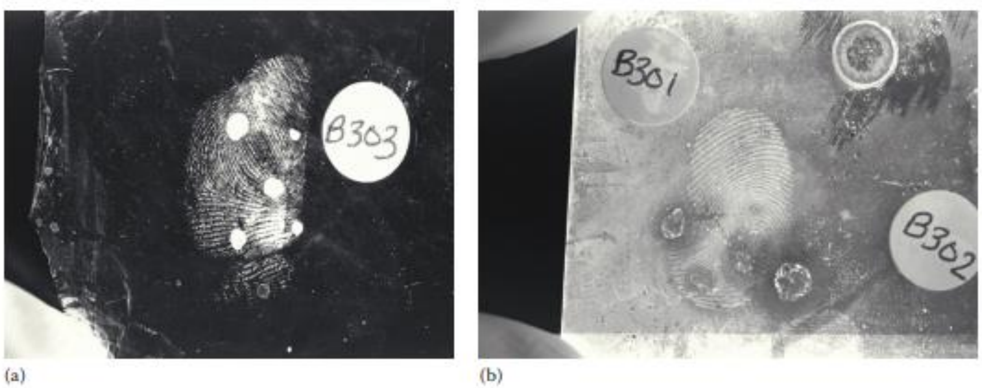


Fig Effects of liquid CW agents on friction ridge impressions: (a) masking of ridges on a metal substrate and (b) destruction of ridges on a glass substrate.

Above figure shows photographs of friction ridge impressions that have been exposed to sodium fluoroacetate. In Figure a, the sodium fluoroacetate reacts with the CA/BY40 development technique and obscures the friction ridges in the area where the CW residue is located. In another example, shown in Figure b, the friction ridge detail has been destroyed by contact with the sodium fluoroacetate. From the observed effects of liquid contamination, the recovery of friction ridge impressions from areas within the scene that indicate previous splashing or spilling of a liquid agent was determined to be unlikely.

Miskelly and coworkers further investigated the influence of chlorine and hydrogen chloride (HCl) gas on latent friction ridge impressions. The researchers used single donors to place predominantly eccrine-rich or sebaceous/eccrine friction ridges onto glass and photocopy paper substrates for chlorine exposure and glass slides for HCl studies. The friction ridge impressions were exposed to HCl at varying concentrations (8%–19%) for 5h and left overnight before being treated with magnetic bichromatic powder or CA/BY40. Powder dusting of sebum-rich friction ridge impressions was successful under all conditions, although increased background was observed as the HCl concentration rose above 12% due to condensation forming on the glass surface. CA fuming was not possible at HCl concentrations above 8%, which was confirmed by the lack of bands attributed to the ester group (1746, 1150, and 1110cm−1) and the nitrile group (2248 cm−1) in the FTIR spectrum. The inhibition of CA by acidic conditions is well-established and the researchers were able to observe CA development by pretreatment of the friction ridges with alkaline vapors, most notably ethanolamine and triethylamine prior to CA fuming. Figure shows photographs that illustrate the effect of extensive chlorine exposure on friction ridge impressions on glass substrates, including the redemptive effect of triethylamine vapors for successful friction ridge recovery. Soaking samples in 2% sodium hydroxide for 20min as recommended for soot removal from arson exhibits led to friction ridge enhancement using CA, but with significant background development.

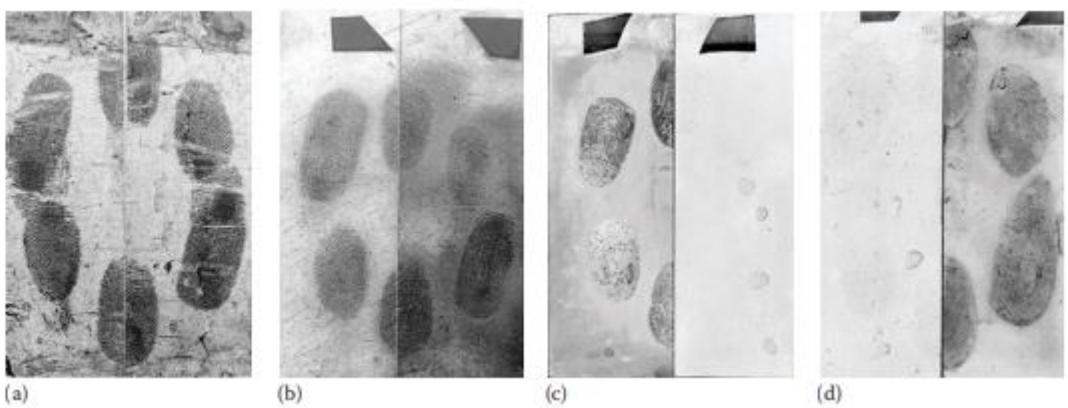


Fig: Effect of chlorine on enhancement of fingerprints on glass. For images (a–c), the left-hand side is a control which has not been exposed to chlorine, while the right-hand side was in an atmosphere containing 4 × 10−4mol/L chlorine for 20min prior to enhancement: (a) SPR, (b) magnetic powder, (c) CA, and (d) both sides were exposed to 4 × 10−4mol/L chlorine with the right-hand side being exposed to triethylamine vapors for 3h before both sides were fumed with CA/BY40.

Friction ridge impressions were exposed to extremely high levels of chlorine for 20min (10,000ppm v/v, well above the immediately dangerous to life or health (IDLH) level of 10ppm). Latent prints on the nonporous substrates were developed using powder, SPR, or CA fuming. The SPR performed well under all conditions (ambient humidity, 60% and 100%); the powder showed increased background with increased humidity levels; and CA fuming failed to develop friction ridges after chlorine exposure.

BIOLOGICAL CONTAMINATION

Bioterrorism is the intentional use or threatened use of viruses, bacteria, fungi, or toxins from living organisms to produce death or disease in humans, animals, or plants, and fear within society. Biological agents can be grouped into three risk categories, based on their potential for adverse public health impact. Category A or risk group 3 organisms can easily be disseminated or transmitted from person-to-person and require special action for public health preparedness. Category B or risk group 2 organisms are moderately easy to disseminate and require specific enhancements of diagnostic capacity and enhanced disease surveillance. Category C or risk group 1 organisms are not readily transmitted from person-to-person and pose the least impact on public health. Biological agents show no immediate effect and in the case of B. anthracis (anthrax) will persist as an endospore resisting UV light, disinfectants, and desiccation, to cause disease upon eventual exposure.

Hoile et al. contaminated latent friction ridge impressions on porous and nonporous items with viable anthrax spores and then subjected these contaminated exhibits to formaldehyde gas, a common and effective decontamination procedure for biological safety cabinets. The experimental design was intended to observe the effects of the decontamination process on the friction ridge development and the biological agent was only present to determine if the fumigation had successfully destroyed the spores. The friction ridges were deposited daily over a 7 day period prior to exposure, using three volunteers to create triplicates for each time period. Researchers inoculated the samples with a 10µL aliquot of Bacillus thuringiensis var. kurstaki (BT) spores (140cfu/µL) and allowed them to air-dry. The inoculated friction ridge samples were exposed to the standard formaldehyde formulation (30mL 37% w/v formalin, 10g KMNO4) or to a revised formulation (15mL 37% w/v formalin, 7.5g KMNO4) both at 65% relative humidity for 40min. Both methods of decontamination were shown to be effective at destroying the spores in reasonable time frames. Latent friction ridge recovery involved DFO, ninhydrin, 1,2-indanedione and physical developer for paper surfaces, and CA/BY40, gray powder, and magna black powder for glass surfaces. The nonporous development techniques, fingerprint powders and CA/BY40, were largely successful (75% and 87.5%, respectively) and showed no differences. in performance between the standard and revised formaldehyde methods. In contrast, all three amino acid reagents, DFO, ninhydrin, and 1,2-indanedione, failed to recover any friction ridge impressions with the standard method and showed compromised detection rates relative to the controls for the revised formaldehyde method (33%, 66%, and 8%), respectively. The researchers observed the effects of formaldehyde gas on serial dilutions of four amino acids. They concluded that this biocidal agent, known to inactivate microorganisms by reacting with carboxyl, amino, hydroxyl, and sulfhydryl groups of proteins as well as amino groups of nucleic bases, likely acts as an alkylating agent on the amino group of the amino acids within fingerprint residues. Once this happens, the amino group is effectively blocked from reacting with DFO, ninhydrin, and 1,2-indanedione.

Latent and blood-contaminated friction ridge impressions on a variety of surfaces were exposed to aerosolized Bacillus globigii (spore), Bacillus atrophaeus (veg), and Pantoea agglomerans (veg) using an aerosol test chamber. Sampling methods established that the bacterial agents were in the agent-containing particles perliter of air(ACPLA)range of 103 , which is the predicted concentration required to kill 50% of exposed people (LD50) and is representative of levels anticipated in a biological attack. A selection of standard chemical techniques was used to detect the contaminated latent and blood friction ridge impressions: paper (DFO and ninhydrin); linoleum (amido black, Hungarian Red, and leucomalachite green); electrical and duct tape (powder suspension); plastic and wax cardboard (CA/BY40); glass and metal (powder). One and seven day old friction ridge impressions were exposed to the bacteria for 24 and 48h periods. The researchers observed no effect of bacterial exposure to the amino acids within a fingerprint residue on porous exhibits (100% recovery for both DFO and ninhydrin compared to the control set). The nonporous enhancement techniques (powders and CA) were mainly unaffected by exposure to bacterial agents (100% and 97%, respectively). Adhesive substrates, as is typical due to their more challenging surface, showed varied results. However, for the six tests involving adhesive substrates, the only below average result was recorded for duct tape exposed to P. agglomerans (veg). The blood detection chemicals also performed well with Hungarian Red showing the highestrecovery rate (97%) and leucomalachite green the lowest (86%), relative to the control samples. There appeared to be no effect as a result of increased exposure time to bacteria on performance of friction ridge detection techniques.

RADIOLOGICAL

Colella et al. studied the impact of ionizing radiation on the detection of latent fingerprints on a range of substrates including glass, hard and soft plastic, aluminum, and paper under conditions designed to mimic the illegal possession and trafficking of radioactive materials. Fingerprint samples were exposed to high doses of gamma irradiation ranging from 1 to 1000kGy before and after treatment with a variety of substrate-specific development techniques. Nonporous samples were processed with one of the following methods: CA/ rhodamine 6G, CA/BY40, and black fingerprint powder. The paper substrates were processed with one of the following methods: ninhydrin, DFO, 1,2-indanedione, and PD. The impact of ionizing radiation appears to be substrate-specific with little to no effect on fingerprint detection being observed for glass or aluminum for any of the methods utilized.

A significant color change was noted for glass. In contrast, polyethylene, polystyrene, and paper showed considerable effects of ionizing radiation at high doses (>100kGy) which was mainly attributed to radiolytic-induced changes within the fingermark as well as degradation of the substrate. Several previous studies into the effects of ionizing radiation on physical evidence focused on the use of electron beam irradiation as a decontamination technique for biological materials.

DECONTAMINATION

Decontamination is the destruction and removal of chemical and/or biological agents. For chemical agents, decontamination may be accomplished by physical removal and/or chemical neutralization (conversion of the toxic chemical into a harmless product through chemical reaction). Physical removal can be achieved by flushing the surface with water or aqueous solutions, scrubbing, or scraping bulk agent from the surface. In addition to mechanically removing the CW agent, application of large quantities of water or aqueous solutions may slowly hydrolyze the agent. However, the limited solubility of CW agents in water will limit the hydrolysis reaction in the absence of hypochlorite solutions. The most important category of chemical decontamination is oxidative chlorination (i.e., hypochlorite solutions, which act universally against organophosphorus and mustard agents). Chemical hydrolysis is most effectively achieved under alkaline conditions when the hydroxide ion initiates nucleophilic attack of the phosphorus atoms in VX and G-agents. The reaction rate is dependent on the chemical structure and environmental conditions such as pH, temperature, presence of catalytic agents and solvents.

For biological agents, decontamination includes both sterilization (the complete destruction of all microorganisms, including bacterial spores) and disinfection (the destruction and removal of specific types of microorganisms). Methods of sterilization include application of heat, chemicals, irradiation, high pressure, or filtration. Disinfection can be defined as cleaning an object of some or all of the pathogenic organisms which may cause infection. CBRNE-trained crime scene examiners would be able to examine exhibits after decontamination, so it is important for them to understand how the presence of decontamination agents used to neutralize biological and chemical agents affects the performance of friction ridge reagents. In an ideal world, CBRNE-trained crime scene examiners would be able to remove exhibits from the scene after decontamination and safely examine them back at the forensic identification laboratory using the full complement of detection techniques available.

Ramotowski and Regen examined 320 latent friction ridge impressions deposited by five donors onto two types of porous substrate (Xerox and white, blue lined paper) and three types of nonporous substrates (PVC, Ziploc bags, and black polyethylene garbage bag material). The deposited friction ridge impressions were aged for at least 7 days before being cut in two; one half was used as a control and the other was irradiated. Porous exhibits were treated with ninhydrin, DFO, physical developer, iodine, black powder, magnetic black powder, and silver nitrate. Nonporous samples were treated with CA, CA/RAM, CA/BY40, MMD, VMD, gentian violet, Sudan black, nonmagnetic and magnetic black powder. Although the exact conditions and irradiation doses were not specified due to operational security, the doses were sufficient to produce a range of effects on the substrates, including discoloration of porous substrates to a faint yellow compared to the controls and wrinkling of the polyethylene garbage bags. For porous substrates, these changes were accompanied by noticeable decreases in the intensity of both the colored Ruhemann’s purple product observed with ninhydrin and the fluorescent product for DFO.

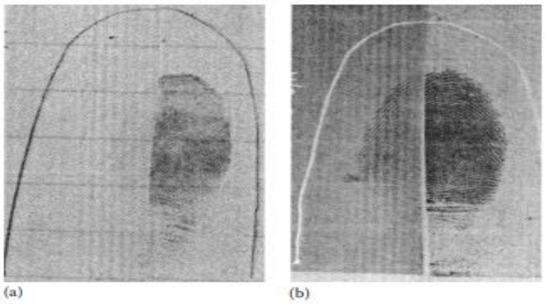
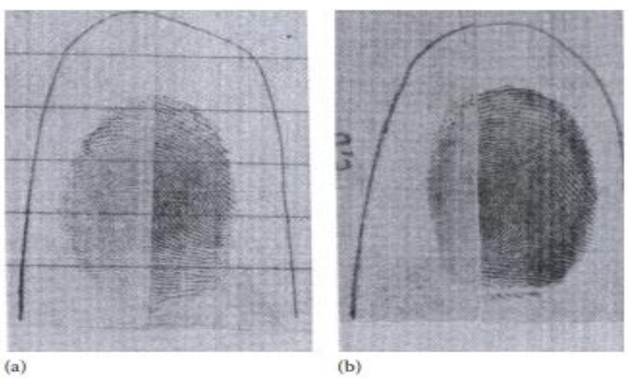


Fig: (a) The difference in initial DFO color development between the irradiated samples (left) and the control sample (right) and (b) an example of the difference in DFO fluorescence intensity between the irradiated (left) and control.

Iodine and both nonmagnetic and magnetic black powder did not produce good results and silver nitrate failed to produce any friction ridge detail on the irradiated samples. In contrast, physical developer showed improved development forthe irradiated samples.



Fig(a) The difference between the intensity of PD development between the irradiated (right) and control (left) samples and (b) a similar example in which there is also a noticeable difference between the irradiated (right) and control.

Canadian Aqueous System Chemical/ Biological Agent Decontamination (CASCAD™) is a bleach-based decontamination agent containing buffers and surfactants. MDF LSA-100 is a similar product manufactured in the United States. The purpose of such decontamination agents is to inactivate the CW and/or BW agent. A consideration when decontaminating following fingerprint development is the possibility that the CW agent may become trapped within the matrix of the fingerprint development medium and could off-gas at a later time. Wilkinson et al. applied CASCAD to friction ridge impressions on a variety of substrates contaminated with different CW agents both before and after development with appropriate detection techniques [52]. Of the 31 fingerprints passively decontaminated with CASCAD (i.e., no scrubbing) following treatment with a variety of development techniques, 25 survived. The majority of the destroyed fingerprints had been treated with powder before decontamination. Decontamination of exhibits prior to fingerprint development significantly reduced the number of identifiable fingerprints recovered. Tests using control samples that were not exposed to any CW agents before decontamination with CASCAD showed that the number of friction ridge impressions recovered was significantly reduced. The same observation is true when considering the sample set exposed to sarin before decontamination and subsequent fingerprint development. Although not tested on friction ridge impression evidence, MDF LSA-100 was tested along with CASCAD on oil- and salt-contaminated footwear impression evidence. When applied prior to footwear development, both decontamination agents destroyed the latent impressions. When applied after treatment with the appropriate development method (iodine and silver nitrate, respectively), both decontamination methods destroyed the oil impressions, but the salt impressions survived the MDF LSA-100 exposure. This suggests that the MDF LSA-100 might be less aggressive to latent friction ridge impressions compared to CASCAD, and at least the salts within the residue may survive passive exposure.

For radiological agents, such as cesium 137, strontium 90, and americium 241, Colella and coworkers optimized two decontamination procedures for use on paper; one physical and one chemical Due to limited availability of strontium 90 and americium 241, strontium 85 and uranium 238 (yellowcake [U3O8]) were considered as suitable surrogates as they have similar physical and chemical properties. The physical decontamination method involved the physical scraping of the surface with a hard, straight edge (e.g., scalpel or knife) followed by the use of a pencil eraser. This process is recommended when the contaminating radioisotope is in a solid form (i.e., yellowcake). The chemical technique involved 5min of sonification in either a 2% aqueous or 2% cyclohexane solution of decontaminating agent DEZ-1. When the contaminating radioisotope is in the liquid form (i.e., cesium or strontium), the chemical method is recommended. It is important to note that the researchers did not observe 100% removal of any contaminating radioisotope from the paper surface for either the physical and chemical decontamination procedures. Rather they suggest that both of these decontamination procedures be consider primarily as reducing the levels of contamination. Further consideration of the radiological clearance standards of the appropriate authorities was recommended to determine whether the post-decontamination evidence could be classified as “safe.” For the Australian Nuclear Science and Technology Organisation’s (ANSTO) radiological clearance standards, the decontaminated samples were classified as having safe levels of radiation. With respect to the affect of these two decontamination procedures on the detection of latent fingerprints, no technique was successful following decontamination. The fingerprint detection methods studied included DFO, ninhydrin, 1,2-indanedione/zinc chloride, and physical developer. DFO and physical developer were able to detect fingerprints when the chemical decontamination procedure followed the fingermark development. The physical decontamination procedure had no impact when applied after any fingerprint development techniques tested in the study.

EXPLOSIVES

In 2006, Lanagan deposited sebaceous-rich friction ridge impressions on metal and plastic surfaces within a vehicle as well as on metal exhibits placed on the front and rear seats. All latent friction ridge impressions were clearly visible using oblique lighting. A galvanized pipe bomb containing 0.25 lb of Semtex (an ammonium nitrate–based dynamite) was positioned under the dashboard in the area of the foot pedals. A second device containing 2.5 lb of composition B (mixture of cyclotrimethylenetrinitramine [RDX] and trinitrotoluene [TNT]) was positioned between the front seats. The vehicle was subjected to both detonations prior to evidence recovery. All recovered items were examined for friction ridges using a Reflected UltraViolet Imaging System (RUVIS), followed by CA fuming and powders. The momentary exposure of the latent impressions to the heat and flames of the explosions was sufficient to destroy most of the friction ridge detail and the remaining fragments were unsuitable for comparison. More recently, Gardner described the detection of a latent fingerprint from a detonated improvised explosive device (IED) using RUVIS. The fingerprint, located on a plastic bottle used to hold a mixture of nitromethane and gasoline, was identified to the individual who had constructed the IED. The individual had not been instructed to deposit fingerprints onto the device during construction, so the detection implied that under these conditions latent fingerprints could survive the explosion.

A controlled experiment examined how the distance of the latent impressions from the blast affected friction ridge recovery using CA. Aluminum and steel plates containing latent friction ridge impressions were located 0.25–1m from a 0.7kg charge of composition B and between 0.125 and 0.5m from a 0.09kg explosive charge of composition B. Four friction ridge impressions were deposited on each side of the polished metal plates which were positioned so that one side was oriented away from the explosive charge. Following each detonation, the plates were recovered and processed with CA and Ardrox 970 P25 before being examined using UV radiation. The researchers observed that damage was greater on the aluminum plates compared to the steel plates, even though they were the same distance from the blast. They postulated that the lighter-weight Al plates were carried by the blast, resulting in an increased exposure to the shockwave that caused greater damage from the excessive blast pressure and heat. Post-blast, the steel plates were observed in their original location. Aluminum is less stiff than steel and will more easily deform under such loading. The researchers determined that there was an approximate correlation between the survivability of latent fingerprints and the distance that the friction ridge impression was located from the blast. They were able to recover latent friction ridge impressions using CA and Ardrox on both sides of the plates when they were located 0.75m from the 0.7kg charge and 0.5m from the 0.09kg charge. Friction ridge impressions were recovered from all plates, even those severely deformed by the blast.

(a)

(b)

Figure shows an aluminum plate after exposure to a 0.7kg explosive charge located 0.25m away and the friction ridge impression that was developed on the surface by CA/Ardrox.

CONCLUSION

First, CA fuming is the only friction ridge detection method that has been tested in some manner on nonporous exhibits exposed to all of the above hazardous environments. More importantly, researchers were able to successfully recover latent friction ridge impressions for these challenging environments under certain conditions using CA fuming and dye staining. Successful detection of latent fingerprints by CA following exposure to ionizing radiation (cobalt 60 gamma irradiator) was shown to be substrate-dependent. Glass and metal could be effectively treated with CA even after exposure to high dose rates of above 1000kGy whereas plastics such as polyethylene and polystyrene showed reduced recovery rates above 500kGy. For environments known to inhibit CA polymerization, such as the formation of acidic conditions from Cl and HCl exposure, CA was still successfully used following ethanolamine pretreatment. Fingerprint powders and powder suspensions were less widely studied but proved to be effective techniques. For porous substrates, traditional methods such as DFO and ninhydrin produced excellent results, but it was the performance of PD that was consistently noted to recover latent friction ridge impressions under a wide range of extreme conditions, including improved performance following electron beam irradiation. Attempts to develop latent fingermarks on paper exposed to ionizing radiation at doses above 500kGy failed for all fingerprint detection methods due to the significant degradation in the mechanical properties of the substrate. Although limited, the research to date supports the inclusion of CBRNE-trained crime scene examiners as members of CBRNE response teams since several studies established that treatment of exhibits for friction ridge impressions was more successful before decontamination of the substrate is attempted.

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INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2021-2022

COURSE: M.Sc. FORENSIC SCIENCE

SEMESTER: III

SUBJECT: PSFSQ302 - ADVANCED FINGERPRINT TECHNOLOGY - I

TOPIC FOR PRESENTATION: ARSON - Effects of Flammable Liquids on Latent Friction Ridge Impressions, Recovery, Recovery of Friction Ridge Impressions in Blood

PRESENTED BY: POOJA CHANDRAN

ROLL NO: 17

INDEX

DEVELOPMENT OF FINGERPRINTS FROM CHALLENGING SURFACES: ARSON

Arson is often used as a mode of concealment due to the wide misconception that fire destroys fundamental evidence and subject matter experts often assume that charred or soot-covered fire debris offers no hope for the detection of friction ridge impressions or DNA evidence.

Advances in recent research and technologies have meant that techniques have been developed to further aid and enhance the recovery of evidence that has been exposed to the extreme conditions of a fire.

While there is no doubt that the physical and chemical properties of friction ridge impressions will be affected by the extreme environment created by fire, such as elevated temperatures, water exposure, and high levels of gases (e.g., carbon monoxide and carbon dioxide), but friction ridge impressions and even DNA can survive such exposure.

Actions taken at the outset of a fire investigation can play a pivotal role in the successful resolution of the case and thorough intelligence-led investigation is the key to ensuring that potential physical evidence is not overlooked, tainted, or destroyed. It is recommended that a fingerprint be processed as soon as possible to minimize deterioration. Often the investigation attendance is several days after the incident. This timeframe poses a risk to the possibility of fingerprint recovery.

In the forefront of all fire investigations where evidence recovery is paramount, the stages of the fire should be taken into consideration and pre-eminent soot removal techniques carried out in order to expose and visualize any evidence present.

Recent work has demonstrated that objects close to the seat of the fire may yield friction ridge impressions if the surface has been covered by soot or debris to protect it from the flame. It may act as a protective shield to the fingerprint from the intense heat and extinguishing. Even badly damaged objects should be considered, as the underside may be relatively undamaged and yield friction ridge impressions. Forensic examination of arson scenes should be pursued so that valuable physical evidence, such as friction ridge impression and DNA evidence that could be used to identify the suspect, is not overlooked

As soot is often produced by fire it would be reasonable to explore how soot affects fingerprints. When a fire has reached an intense phase, soot can deposit on items. There are several different phases a fire will reach and the phase the fire may have reached before becoming extinguished can give an indicator to the level of soot deposition and damage. Commonly there are four phases of a fire–incipient; emergent smouldering; fully developed, and oxygen regulated smouldering. Incipient is the first phase of burning. This may last from one hour to several days. Little smoke is generated at this stage. During emergent smouldering or growth, the temperature of the room will increase slightly and flames will reach 1000°C. During the fully developed fire stage the temperature will continue to increase until items reach ignition temperature. This causes flashover to occur where flames spread over simultaneously, commonly, when the ceiling temperature is 500°C to 600°C. The temperature of the room will increase. The heat from the origin is converted into the higher points of the

room where it accumulates and radiates downward. The heat impact on fingerprints is reduced at lower points of the room. During the flashover, the soot and smoke are commonly consumed as fuel and in this circumstance, the protected fingerprints can become exposed. A clean burn to the surface occurs at a fire scene when a surface is exposed to direct flame impingement. The direct flame contact causes the soot deposits to be burned away, leaving a clean area.
The carbon by-product from the gases produces soot. Self-extinguishment may occur due to the deficit of oxygen resulting in the room being covered in soot. The smoke and soot are a source of fuel that can be used by the fire under suitable conditions.

FINGERPRINT DEPOSIT COMPONENTS AND THEIR REACTION TO FIRE

The understanding of how fire, elevated temperatures or water may affect the components of a fingerprint is important and ensures that the most beneficial enhancement techniques are used without destruction of the fingerprint. Eccrine glands secrete 98% water, the remaining 2% consists of mineral salts, sugars, urea and organic acids. These glands are located on the palms, fingertips and soles of the feet. A fingerprint with only eccrine components is considered a clean print.

The majority of water in a fingerprint deposit will be rapidly evaporated when exposed to excessive heat and proteins are likely to be denatured into soluble amino acids. Oils may survive in the beginning, however, will evaporate when exposed to prolonged heat. The most fire-resistant component of the fingerprint deposit is salt, however, salt is soluble in water and may be exposed to water during fire extinguishing and in turn possibly damaging the fingerprint. In a normal situation in which fingerprints are deposited they begin to deteriorate and will lose distinctness. Factors that affect the rate that this occurs are evaporation of the volatile components such as water, diffusion through and over the substrate and light or heat induced chemical breakdown.

EFFECTS OF FLAMMABLE LIQUIDS ON LATENT FRICTION RIDGE IMPRESSIONS

Liquid accelerants are often found in arson scenes as they are used to set fire due to less time required for ignition and the ease of accessibility. Considerations will need to be made with regards to treating items that have been in contact with flammable liquid as it can dissolve the fatty constituents of the fingerprint.

- Mary Anne Vaughan promoted rinsing soot-covered exhibits such as glass, doorknobs, flammable liquid containers, and car door handles under running water, claiming that fingerprints appeared “etched” into the glass. The presence of flammable liquids on the surface of the substrate has been reported to decrease the effectiveness of soot removal techniques. The recovery of soot-developed friction ridges by water rinsing described by Vaughan was compromised by liquids such as gasoline and kerosene. The hydrophobic nature of these flammable liquids repels water from the surface impeding soot removal.

- In contrast, Tyranski Warren and Nicholas Petraco believed that the presence of gasoline in a plastic bowl, used to transport and distribute gasoline throughout an apartment that was subsequently set on fire, had created a plastic friction ridge impression in the rim of the plastic bowl. The plastic bowl was slightly soluble in the gasoline and the action of carrying the gasoline-filled vessel had resulted in a molded impression being left in the plastic. The impression was retrieved using silicone casting materials to create a three-dimensional impression, which was transferred to white paper by covering the surface with black ink. The friction ridge impression was identified to a suspect in the arson case.
- The belief that flammable liquids such as gasoline, kerosene, diesel oil, and turpentine destroy latent friction ridge impressions by dissolving the fatty constituents was challenged in the mid-1990s by an Israeli National Police research team. They briefly immersed freshly deposited impressions into several fire accelerants and using SPR and CA, they detected the friction ridge impressions several days after being immersed. Although the team established that immersing friction ridge impressions in gasoline significantly impaired soot removal, they were still able to recover identifiable friction ridge impressions on 34% of the glass slides previously immersed in gasoline.
- Research conducted by the Bundeskriminalamt (BKA) in Germany into soot removal techniques also considered the effects of three fuel mixes on friction ridge detection. A male donor deposited latent friction ridge impressions on the glass neck and body (glass and paper label) of glass bottles that were subsequently filled with one of the following three accelerants: super unleaded gasoline, a gasoline/diesel (6:4) mix, or gasoline/engine oil (7:3) mix. The samples were un-ignited or ignited and thrown against a test wall. The ignited bottles were either allowed to burn out or extinguished. The soot removal methods involved the use of compressed air, brushing, and adhesive foil tape lifts. They observed that the fuel mixes left greasy residues on the glass which could be removed by the adhesive tape but that long-term immersion in fuel tended to destroy the friction ridge impressions on glass. This is in contrast to the Israeli results, but may depend on the length of time the latent friction ridge is immersed in the accelerant.
- K.M. Stow and J. McGurry prepared Molotov cocktails using clean glass bottles that had both good and poor-quality friction ridge impressions placed on the glass and plastic label surfaces. The bottles were carefully filled with gasoline or a gasoline/motor oil (1:1) mix and a cotton/polyester wick was inserted into the neck. Each Molotov cocktail was ignited, thrown against a pre-cleaned detonation area, and allowed to burn out naturally. Over 90% of the contaminated glass fragments from each bottle were recovered and subjected to different soot removal techniques before friction ridge recovery with CA/BY40. The researchers observed that it was particularly difficult to develop marks which had been exposed to the gasoline and motor oil mix due to the persistence of the oil on the surface. They observed the greatest success at

recovery from these heavily contaminated friction ridge impressions when the glass fragments were soaked in 2% sodium hydroxide, sometimes for up to 30 min.

RECOVERY OF LATENT FRICTION RIDGE IMPRESSIONS

It is important to be aware of the circumstances and conditions an item or substrate may have undergone to recognise what treatment will be the most effective. The fingerprint may be subjected to many different conditions depending on - their location in relation to the fire; whether the fingerprints were exposed to water during extinguishing efforts; and, whether they were exposed to soot. If the quality of the print before the fire was poor then it is likely the recovery of fingerprints will not be possible. The longer the exposure the fingerprint has to the intense conditions, the lower the quality of ridge detail the fingerprint displays.

The components that would normally be targeted may not be in the same condition as they would be when recovered from a normal crime scene. Understanding the target components and the conditions that may affect them will allow the investigator to identify the most appropriate technique. For example, some techniques such as DFO, Ninhydrin, and Physical Developer will only work on porous materials whereas, Superglue Fuming, Vacuum Metal Deposition and Small Particle Reagent are suitable for non-porous materials. These methods also greatly depend on the condition of the substrate surface; if it has melted or badly charred, the chances of fingerprint recovery are very slim. Also, the method of extinguishment needs consideration. A high level of water contamination from the use of hoses and condensation, particularly on porous substrates, will not develop as the amino acids targeted in these techniques e.g., Ninhydrin are water-soluble. Other techniques such as Physical Develop are more appropriate if the substrate is wet, as it reacts with the fat constituents in the skin that are not water-soluble.

Marks tended to survive on surfaces that had some degree of protection, such as those facing downwards or on articles placed below a chair or in waste bins. Therefore, it is objects in these locations or situations that should be obvious targets for recovery from the scene and subsequent fingerprint development processes. However, there are some remarkable exceptions to this generality. Consequently, no items within fire scenes should be overlooked for recovery simply because they appear to have been severely damaged as a result of the fire, be it due to smoke deposition, radiated heat or direct flame impingement.

- In some circumstances it has been recorded that the action of the fire alone has enhanced the fingerprint. In some situations, soot and tar will deposit on the fingerprint ridges allowing the fingerprint to become developed by the fire itself. The fire may have contributed to the development of the fingerprint in the same way as the fingerprint visualisation technique known as the flame technique or soot deposition. Fingerprints are also known to ‘bake on’ on metal substrates.

- Olsen noted the accidental development of latent fingerprints on magazine paper resulting from the heat of a fire and illustrated fingerprint impressions that were identified to the arsonist.
- Brown AG, Sommerville D, Reedy BJ, Shinnon RG, Tahtouh M. observed that rapid heating of latent fingerprint impressions on a variety of porous surfaces in air, over a temperature range of 220°C–300°C, resulted in fingerprints that initially could be seen to fluoresce under green illumination (505 nm) but with continual heating would eventually appear dark brown under white illumination until they lost contrast due to background charring. The researchers noted that these observations held for both eccrine- and sebaceous-rich impressions.
- In contrast a study involving a variety of aged latent fingerprint impressions deposited onto white recycled paper, exposed to longer heating regimes at lower temperatures (160°C–180°C) compared to Brown et al., showed that only the eccrine component fluoresced.
- In the early 1980s, it was suggested that simply breathing onto the arson exhibit could re-hydrolyze dried friction ridges and improve the adhesion of fingerprint powders.
- Shelef R, Rhima I, Elkayam R. examined the ability of several friction ridge detection techniques, including SPR, CA/BY40, silver-black powder, crystal violet, and forensic light source examination (λEx = 450 nm, λEm = 550 nm), to detect freshly deposited impressions that had been briefly immersed in a variety of fire accelerants. Some of the friction ridges following exposure to the accelerant were left for several days before being processed. The researchers were able to recover 80%–90% of the 5-day old impressions and 50%–60% of the 13-day old impressions using either SPR or CA. Although the CA process showed a slightly improved performance compared to SPR, the CA technique was abandoned as it was difficult to implement at the scene. Further work by the group resulted in an optimized SPR formulation for latent friction ridge impressions on glass surfaces that have been washed with accelerant fluids.
- Simulated Molotov cocktail exhibits prepared by filling glass bottles with different fuel mixes were thrown against a test wall and either were allowed to burn out, were extinguished, or were not ignited. The glass surface was examined using the following sequence of techniques: visual examination under white light, forensic light source, and CA followed by vacuum metal deposition (VMD). It was reported that removal of the soot layer without impairing the friction ridge impressions was difficult. No data on the performance of specific detection techniques were provided, except that ninhydrin proved to be very effective at recovering latent friction ridge impressions on the paper labels.
- Glass bottles, on which latent friction ridge impressions had been placed, were also tested by Wyllie J using a mock living-room fire scene in which significant smoke was allowed to develop before the fire was extinguished. The areas known to have friction ridge impressions were examined using white and ultraviolet (UV) radiation prior to soot removal with 2% sulfosalicylic acid and 0.1 M sodium hydroxide rinsing solutions. The glass was re-examined with white and UV radiation before half of the bottles were treated with aluminium powder and the remaining bottles were treated with CA/BY40.

A total of 18 sets of fingerprints were recovered from the glass bottles using this soot removal method and either powder or CA/BY40.

- In another experiment, aluminium powder, SPR, and Sudan black were used to detect both natural friction ridge impressions and those contaminated with gasoline and a gasoline/motor oil mix (1:1) that had been subjected to controlled burns and sodium hydroxide wash solutions for soot removal. Both aluminium powder and SPR performed well, although adding motor oil to the incendiary mixture resulted in residue on the glass surface that prevented either development technique from being effective. In field tests, friction ridge recovery was attempted using CA/BY40 after the glass incendiary devices were detonated, which resulted in much heavier contamination of accelerant. Under these conditions, friction ridge recovery was compromised but still possible.
- A recently published comprehensive study regarding the recovery of friction ridge impressions from arson was reported by Bleay and co-workers. Rather than comparing existing methods of friction ridge recovery, the researchers first tried to establish the range of temperatures and exposure times for which latent friction ridges can survive. They developed a best practice for soot removal and subsequent friction ridge recovery on a variety of nonporous and porous substrates likely to be encountered at typical arson scenes. Extensive laboratory trials established that a wide variety of methods included in the HOSDB Manual of Fingerprint Development Techniques will develop friction ridges that have been exposed to temperatures up to 200°C, although their effectiveness may be reduced especially with increased exposure time. All arson examinations should begin with a thorough visual inspection since the action of heat and soot can develop friction ridge impressions on exhibits. The development may be due to preferential soot deposition onto ridges, heat development of friction ridges on paper, and impressions being “baked” onto metal surfaces. Black or white powder suspensions proved to be the best treatment for nonporous surfaces exposed to temperatures up to 200°C. These methods were also effective for adhesive substrates. For nonporous substrates above 200°C, superglue fuming was most effective, providing the surface was dry and VMD was the technique of choice if the surface had been wet. For porous substrates, DFO was the best performing method, providing the surface had not been exposed to water. Physical developer was the reagent recommended for porous substrates that had been wet.

RECOVERY OF FRICTION RIDGE IMPRESSIONS IN BLOOD

It is important to understand the way blood would behave in such an environment, especially when a fingerprint can be made in blood. Heme protein dyes will stop working at 100-150°C which is before protein-specific dyes at 200°C when treating fingerprints in blood. This indicates the Heme protein in the red blood cells will denature before the protein components in the plasma of the blood.

Blood can either be detected by a chemical reaction with the heme constituent in the haemoglobin protein or by the use of a protein stain.

- Examples of **heme-specific** reagents include leucomalachite green and luminol. The catalytic action of the heme cleaves hydrogen peroxide into two hydroxyl ions that oxidize the blood reagents into their colored form.
- Examples of **protein dyes** include acid black 1 (also known as amido black), acid violet 17, and a dye that produces a fluorescent yellow product, acid yellow.

The effect of heat and soot on the recovery of blood from arson scenes has not received much attention in the literature.

- Amido black was used successfully to recover friction ridges in blood following detonation and soot removal with 2% sodium hydroxide. Two glass bottles with four blood depletion impressions were detonated with gasoline or gasoline/motor oil mix (1:1) and allowed to burn. The glass debris was treated with sodium hydroxide, followed by amido black. The gasoline/motor oil mix bottle was also subjected to a 2% 5-sulfosalicylic acid solution prior to soot removal. Good quality impressions were recovered in both instances.
- The characteristic chemiluminescent reaction between BlueStar, a commercial formulation of luminol (5-amino-2,3-dihydro-1,4-phthalazinedione), and blood is frequently used to observe transfer patterns within a crime scene and, although the use of such chemicals for friction ridge recovery is unlikely, it is possible that palm prints or sole impressions may be observed. Collins described the use of BlueStar to detect footwear impressions from a homicide scene that had been burnt to conceal the crime. The blue chemiluminescence that results when BlueStar reacts with blood was observed despite all surfaces being covered in a creosote-type soot produced by a mattress that had been burnt within the scene.
- Bleay and coworkers described the range of temperatures and exposure times for which blood detection was possible and published best practices for recovery of friction ridge impressions in blood from arson environments. The researchers observed that when blood was exposed to temperatures above 200°C, none of the known development processes for recovering fingerprints in blood remain effective. Figure 14.10 shows photographs of friction ridge impressions in blood that have been treated with either acid black 1, acid violet 17, or acid yellow 7, after being subjected to 100°C or 200°C for 8 h compared to a control set that were not subjected to heat. Heme-specific leucocrystal violet (LCV) failed at temperatures between 100°C and 150°C. The maximum temperature at which blood was still observed to react with protein dyes was shown to be surface-dependent and may be related to the reactive materials in the surface (e.g., copper and zinc in brass) catalyzing the breakdown of the blood proteins relative to inert surfaces (e.g., ceramic). Before burning off, blood deposits formed a protective layer on the surface creating a difference in the surface oxidation where ridge detail existed and the unprotected area. Processes sensitive to surface differences such as VMD were able to detect fingerprints in blood heated to 900°C, although it is no

longer possible to state that the marks were originally blood. Black powder suspension was also observed to enhance contrast.

CONCLUSION

There is a widespread misconception that fire will destroy all fingerprint evidence. Evaluation of current literature available has shown that fingerprints can indeed be recovered with excellent results. Fire scenes, in particular deliberate or arson, can be examined with reference to the elevated temperature conditions at each stage and the understanding of the soot removal techniques is paramount to the investigation process. Further research is required to make advancement in fire scene fingerprint recovery.

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Submitted as part of Internal Examination

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2021-2022

COURSE: M.Sc. FORENSIC SCIENCE (QUESTIONED DOCUMENTS, FINGERPRINTS AND FORENSIC PHYSICS)

SEMESTER: III

SUBJECT: PSFSQ 303 - MATERIALS AND ANALYTICAL TOOLS

TOPIC FOR PRESENTATION: Nuclear Magnetic Resonance Spectroscopy & Neutron Activation Analysis

PRESENTED BY: POOJA CHANDRAN

ROLL NO: 17

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NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY(NMR)

Nuclear magnetic resonance spectroscopy, most commonly known as NMR spectroscopy or magnetic resonance spectroscopy (MRS), is a spectroscopic technique to observe local magnetic fields around atomic nuclei.
It is a spectroscopy technique which is based on the absorption of electromagnetic radiation in the radiofrequency region 4 to 900 MHz by nuclei of the atoms.

Over the past fifty years, NMR has become the preeminent technique for determining the structure of organic compounds. Of all the spectroscopic methods, it is the only one for which a complete analysis and interpretation of the entire spectrum is normally expected.
Nuclear Magnetic Resonance (NMR) spectroscopy is an analytical chemistry technique used in quality control and research for determining the content and purity of a sample as well as its molecular structure.

For example, NMR can quantitatively analyze mixtures containing known compounds. For unknown compounds, NMR can either be used to match against spectral libraries or to infer the basic structure directly. Once the basic structure is known, NMR can be used to determine molecular conformation in solution as well as studying physical properties at the molecular level such as conformational exchange, phase changes, solubility, and diffusion.

- CRITERIA

- Nuclei should be NMR active
- Apply an external magnetic field
- Supply energy in the form of EMR (Radio waves) that resonates the energy gap

- NMR ACTIVE AND INACTIVE ELEMENTS

Elements with both atomic number and atomic mass number even do not have the property of nuclear spin and therefore are **NMR inactive** while elements with either atomic number or atomic mass number odd show nuclear spin and therefore are **NMR active.**

e.g., ${}^{12}_{6}C$ and ${}^{16}_{8}O$ are inactive elements while ${}^{2}_{1}H$, ${}^{10}_{5}B,$ ${}^{14}_{7}N$ and ${}^{13}_{6}C$ are active elements.

- PRINCIPLE

- Like the electrons of the atom, the nucleus too has a spinning motion. Due to this spinning motion, nucleus acts as a magnet. Molecules have electromagnetic fields derived from their electrons and nuclei.
- Nuclei have spinning motion in random directions, but when a magnetic field is supplied, they twist to align themselves in 2 possible directions - with the field of the larger magnet or against the field.

- The lower-energy state with the proton aligned with the field is called the alpha spin (α-spin) state. The higher-energy state with the proton aligned against the external magnetic field is called the beta -spin (β-spin) state.
- In the absence of an external magnetic field, the nucleus has random orientations. When an external magnetic field is applied, each proton in a sample assumes the α or β state.
- When the nucleus interacts with a photon of just the right amount of electromagnetic energy, the proton's spin can flip from α to β or vice versa. A nucleus aligned with the field can absorb the energy needed to flip and become aligned against the field.
- When a nucleus flips its spin, it is said to be in resonance and its absorption of energy is detected by the NMR spectrometer. Therefore, NMR Spectroscopy is a type of Absorption spectroscopy.
- The energy transfer takes place at a wavelength that corresponds to radio frequencies and when the spin returns to its base level, energy is emitted at the same frequency.
- The signal that matches this transfer is measured in many ways and processed in order to yield an NMR spectrum for the nucleus concerned.

➢ INSTRUMENTATION

An NMR spectrometer consists of parts like -

1. **Sample holder:** Generally, glass tubes are employed which are sturdy, cheap, and inert which are 8.5 cm long, and has a diameter of 0.3 cm. The cell is rotated at a speed of 30 revolutions per second.
2. **Permanent magnet:** It provides a homogeneous magnetic field at 60-100 MHz
3. **Magnetic coils:** These coils induce a magnetic field when current flows through them.
4. **Sweep generator:** To produce an equal amount of magnetic field pass through the sample. It helps to modify the strength of the applied magnetic field.
5. **Radiofrequency transmitter:** A radio transmitter coil that produces a short powerful pulse of radio waves. It can apply a frequency of 60, 90, 100, 220, 300 and 400MHz depending on the resolution of the instrument.
6. **Radiofrequency receiver:** A radio receiver coil that detects radio frequencies emitted as nuclei relax to a lower energy level.
7. **Solvents:** Since we are analysing the organic compounds based on their hydrogen atoms (protons), the solvents with hydrogen can pose a problem. So, solvents that do not contain a proton are utilized for the NMR spectroscopy.
8. **Reference standard:** Since there are chances of many peaks in the NMR data. A reference peak is necessary for comparison and measurement. For this purpose, a substance called tetramethyl silane is used (TMS). This TMS is both chemically and magnetically neutral. It shows a single sharp and easily recognizable peak.

➢ WORKING

The sample which is in the form of a solution is loaded in the sample holder.

There are two types depending upon whether the EMR is kept constant or the Magnetic field is kept constant. If the Magnetic field is kept constant, the Helmholtz coils would be absent.

The radiofrequency generator generates the radio frequency in terms of megahertz and will be aligned due to its radiofrequency. the tube spins to ensure exactly all parts of the sample experience the same magnetic field.

The magnetic field generated by the two magnets is controlled by the sweep generator (2 Helmholtz coils help in the same). Increased magnetic field better the resolution direction of this magnetic field is perpendicular to the Radiofrequency.

When magnetic fields strength exceeds that of radiofrequency, the nuclei resonates. The receiver coil receives the signal and will pass the signal towards the amplifier. The amplifier amplifies the signal and sends the signal to the detector. The detector detects and the Oscilloscope generates the spectra.

- SHIELDING

- Protons in chemical compounds are not isolated, they are surrounded by electrons that partially shield them from the external magnetic field. The electrons circulate and generate a small induced magnetic field that opposes the externally applied field.
- In a molecule, the electron cloud around each nucleus rotates in response to the external field. This induced rotation is a circular current whose magnetic field opposes the external field.
- The result is that the magnetic field at the nucleus is weaker than the external field, and we say the nucleus is shielded.
- For spin ½ nuclei, the energy difference between the two spin states at a given magnetic field strength is proportional to their magnetic moment. However, even if all protons have the same magnetic moments, they do not give resonant signals at the same frequency values.
- This difference arises from the differing electronic environments of the nucleus of interest.
- Upon application of an external magnetic field, these electrons move in response to the field and generate local magnetic fields that oppose the much stronger applied field.
- This local field thus “shields” the proton from the applied magnetic field, which must therefore be increased in order to achieve resonance (absorption of rf energy).

$$B_{eff} = B_o - B_e$$

(B_{eff} = Effective Magnetic Field, B_o = Applied magnetic field, B_e = Magnetic field due to Electrons)

- CHEMICAL SHIFTING

Chemical shift is the shift in the position of NMR absorptions which arise due to shielding and de-shielding effect. The number of signals tells us about the number of set of equivalent protons in a molecule. signals are usually reported relative to a reference signal, usually that of TMS (tetramethyl silane). (It is chemically inert, soluble in organic solvents and non-toxic)

Additionally, since the distribution of NMR signals is field-dependent, these frequencies are divided by the spectrometer frequency.

- This operation, therefore, gives a locator number called the "chemical shift" with units of parts per million.
- In general, chemical shifts for protons are highly predictable since the shifts are primarily determined by simpler shielding effects (electron density), but the chemical shifts for many heavier nuclei are more strongly influenced by other factors including excited states.
- The chemical shift provides information about the structure of the molecule. The conversion of the raw data to this information is called assigning the spectrum.

➢ J-COUPLING OR SCALAR COUPLING

- Some of the most useful information for structure determination in a one-dimensional NMR spectrum comes from J-coupling or scalar coupling (a special case of spin-spin coupling) between NMR active nuclei.
- This coupling arises from the interaction of different spin states through the chemical bonds of a molecule and results in the splitting of NMR signals.
- For a proton, the local magnetic field is slightly different depending on whether an adjacent nucleus points towards or against the spectrometer magnetic field, which gives rise to two signals per proton instead of one.
- These splitting patterns can be complex or simple and, likewise, can be straightforwardly interpretable or deceptive. This coupling provides detailed insight into the connectivity of atoms in a molecule.
- Coupling combined with the chemical shift (and the integration for protons) tells us not only about the chemical environment of the nuclei but also the number of neighbouring NMR active nuclei within the molecule.

➢ NMR SPECTRA

The NMR spectra provide us with important information:

1. The number of different absorptions (signals, peaks) implies how many different types of protons are present.
2. The amount of shielding shown by these absorptions implies the electronic structure of the molecule close to each type of proton.
3. The intensities of the signals imply how many protons of each type are present.
4. The splitting of the signals gives information about other nearby protons.

➢ APPLICATIONS OF NMR

- FOOD INDUSTRY

NMR is successfully used in various food systems for quality control and research. It is used to determine the structure of proteins, amino acid profile, carotenoids, etc. It can be used for both quantification and qualification purpose.

- MEDICAL INDUSTRY

The MRI is a specialist application of multidimensional Fourier Transformation NMR. It is also important in Anatomical Imaging. Tissue Perforations studies, measuring physiological functions, Tumour, Protein identification etc.,

- PHARMACEUTICAL INDUSTRY

NMR spectroscopy has been mainly used for the elucidation and confirmation of structures. NMR methods have been introduced to quantitative analysis in order to determine the impurity profile of a drug, to characteristic the composition of drug products, for confirmation of API of drugs and to investigate metabolites of drugs in body fluids.

- FUEL

The use of NMR spectroscopy as a routine analytical tool for process optimization or to follow the progress of separation/extraction efficiency of a particular compound such as kerosene or gasoline.

- FORENSIC SCIENCE

NMR is used for the detection and quantification of trace elements, Narcotic drug identification, poison detection etc.,

NMR Few experiments demonstrated that the NMR can be applied to the study of metabolites in human saliva specimens. Acetate, lactate, ethanol, glucose and some other substances were simultaneously identified and quantitated from the NMR spectra of saliva specimens.

It is a quick and useful technique in characterizing condoms, it was found through experiments that the solid-state NMR is useful for determining the polymer backbone while the liquid state NMR was useful for characterizing even after usage and flushing down the toilet. The information obtained can be used to provide associative evidence between suspect and crime, and so be useful in sexual assault cases.

- LIMITATIONS OF NMR

- Despite all of its upsides, there are several limitations that can make NMR analysis difficult or impossible in certain situations.

- One such issue is that the desired isotope of an element that is needed for NMR analysis may have little or no natural abundance. For example, the natural abundance of 13C, the active isotope for carbon NMR, is about 11%, which works well for analysis. However, in the case of oxygen, the active isotope for NMR is 17 O, which is only 0.035% naturally abundant. This means that there are certain elements that can essentially never be measured through NMR.

- Another problem is that some elements have an extremely low magnetic moment, μ. The sensitivity of NMR machines is based on the magnetic moment of the specific element, but if the magnetic moment is too low it can be very difficult to obtain NMR spectra with enough peak intensity to properly analyze.

- CONCLUSION

- Nuclear magnetic resonance is one of the most powerful tools that are used in terms of the range of systems that can be studied and the nature of the information that can be obtained regarding the system of interest.
- It can provide a wealth of information about the structure, dynamics, chemical environment and identical functional groups of complex organic compounds.
- It is of high Forensic Importance as it is a non-destructive analytical technique.

NEUTRON ACTIVATION ANALYSIS (NAA)

Neutron activation analysis (NAA) is a nuclear process used for determining the concentrations of elements in a vast amount of materials. NAA relies on excitation by neutrons so that the treated sample emits gamma-rays. It allows the precise identification and quantification of the elements, above all of the trace elements in the sample. NAA has applications in chemistry but also in other research fields, such as geology, archaeology, medicine, environmental monitoring, and even in forensic science. (Major, minor and trace elements). About 74 elements can be detected by the NAA.

- PRINCIPLE OF NAA

- This analytical technique bases its principles on the capturing of neutrons by nuclei, by including radioactive emission from the excited nucleus.
- The sample is bombarded with neutrons, causing the elements to form radioactive isotopes which emit particles (e.g., β particles) and radiations such as gamma rays.
- β particle emission is energetically continuous whereas gamma-ray emission is discrete. Hence gamma emission is often measured preferentially, though measurement of β emission is more sensitive.
- Upon irradiation with a neutron, a thermal neutron interacts with the target nucleus via a non-elastic collision, causing neutron capture.
- These unique half-lives are dependent upon the particular radioactive species and can range from fractions of a second to several years.
- Once irradiated, the sample is left for a specific decay period, then placed into a detector, which will measure the nuclear decay according to either the emitted particles, or more commonly the emitted gamma rays.
- Non-elastic collision, the neutron interacts with the target nucleus resulting in the formation of an excited compound nucleus. The binding energy of the neutron with the nucleus results in the excitation energy of the compound nucleus.
- The energy imparted to the product nuclei by the neutron = K.E. of neutron + BE of the neutron in the produced nucleus. The imparted energy excites the nucleus to a high energetic level.
- This excited state is unfavourable and the compound nucleus will almost instantaneously de-excite (relaxes) into a more stable configuration through the emission of particles and one or more characteristic prompt gamma (γ) protons.
- In most cases, this more configuration yields a radioactive nucleus. The newly formed radioactive nucleus now decays by the emission of both particles (α, β, neutron, proton) and one or more characteristic decayed gamma protons.
- This decay process is at much as lower rate than the initial de-excitation and is dependent on the unique half-life of the radioactive nucleus.

- NAA falls into two categories:

1. prompt gamma-ray neutron activation analysis (PGNAA), where measurements take place during irradiation, or

2. delayed gamma-ray neutron activation analysis (DGNAA), where the measurements follow radioactive decay

- FORMS OF NAA

- Destructive (Radiochemical)

- The sample is chemically manipulated after bombardment but before counting.
- If chemical separations are done to samples after irradiation to remove interferences or to concentrate the radioisotope of interest, the technique is called radio chemical neutron activation analysis (RNAA)
- The resulting radioactive sample may be chemically decomposed and the elements are chemically separated (chromatography, ion-exchange, extraction, electrochemical separation)

- Non-destructive (instrumental)

- The resulting radioactive sample is kept intact. It is generally possible to simultaneously measure more than thirty elements in most sample types without chemical processing
- The application of purely instrumental procedures s commonly called instrumental neutron activation analysis (INAA) and is one of the NAA's most important advantages over other analytical techniques.

- INSTRUMENTATION AND WORKING OF NAA

In the majority of NAA procedures thermal reactor neutrons are used for the activation: neutrons in thermal equilibrium with their environments.

The different components of NAA are

- Source of neutron
- Irradiation chamber
- Transportation mechanism
- Detectors

Step1:

- In principle materials can be activated in any physical state, viz. solid, liquid or gaseous. There is no fundamental necessity to convert solid material into a solution prior to activation;
- NAA can perform non – destructive analyses on solids, liquids, suspensions, slurries, and gases with no or minimal preparation. Due to the penetrating nature of incident neutrons and resultant gamma-rays, the technique provides a true bulk analysis.

- Pre-irradiation sample treatment – such as cleaning, drying, or aching, pre-concentration of elements of interest or elimination of interfering elements, sub-sampling, and packing.

Step2:

- Irradiation of samples can be taken from the various types of neutron sources such as Neutron reactors, accelerators, radio isotopic neutrons etc., according to need and availability.

Step3:

- After their radiation the measurement is performed after a suitable cooling time (tc). In NAA, nearly exclusively the (energy of the) gamma radiation is measured because of its higher penetrating power of this type of radiation, and the selectivity that can be obtained from distinct energies of the photons – differently from beta radiation which is a continuous energy distribution.
- The interaction of gamma – and X-radiation with matter results, among others, in ionization processes and subsequent generation of electrical signals (currents)that can be detected and recorded.
- The instrumentation used to measure gamma-rays from radioactive samples generally consists of a semiconductor detector, associated electronics, and a computer-based multi-channel analyser (MCA/computer).

Step4:

- Detection: Most NAA labs operate one or more hyper- pure germanium (HPGe) detectors, which operate at liquid nitrogen temperature (77K). Although HPGe detectors come in many different shapes and sizes, the most common shape is coaxial.
- These detectors are very useful for the measurement of gamma-rays with energies in the range of about 60 keV to 3.0 MeV. The two most important characteristics an HPGe detector are its resolution and efficiency.

Step5:

- Measurement, evaluation, and calculation involve taking the gamma spectra and calculating trace element concentrations of the sample and preparation of the NAA report.
- The acquisition of gamma spectrum via the spectroscopy system is analyzed to identify the radio nuclides produced and their amounts of radio activity.

GAMMA RAYS SPECTROSCOPY

This detects the gamma-ray (prompt and delayed) with gas detector scintillators, semi-conductors. Gamma spectrum is characteristic of the nucleus in the source.

- QUALITATIVE AND QUANTITATIVE ANALYSIS OF NAA

Modern instruments generally monitor the gamma emission from the sample
Stage1: Bombardment for a fixed time
Stage2: Decay for a certain time
Stage3: Recording the spectrum

<u>Qualitative Analysis:</u>

The spectrum analysis starts with the determination of the location of the (centroids of the) peaks.

Secondly, the peaks are fitted to obtain their precise positions and net peak areas. The positions –often expressed as channel numbers of the memory of a multi- channel pulse height analyzer– can be converted into the energies of the radiation emitted; this is the basis for the identification of the radioactive nuclei. On basis of knowledge of possible nuclear reactions upon neutron activation, the (stable) element composition is derived.

- The E of gamma rays is characteristic of the change in nuclear energetic levels for a particular nuclide
- Emission occurs at discrete energies which can be used to identify the emitting nuclide
- peak energy is thus used for qualitative analysis
- In other words, compare gamma-rays spectrum of a sample with those of known nuclides for qualitative analysis
- The combination of the energy of emitted radiation, relative intensities if photons of different energies are emitted and the half-life of the radionuclide is unique for each radionuclide and forms the basis of the qualitative information in NAA.

<u>Quantitative Analysis-</u>

Peak area is used for quantitative analysis

- The amounts (mass) of the elements may then be determined if the neutron fluence rate and cross-sections are known. In the practice, however, the masses of the elements are determined from the net peak areas by comparison with the induced radioactivity of the same neutron activation produced radionuclides from known amounts of the element of interest.
- The amount of the radiation is directly proportional to the number of radioactive nuclei produced (and decaying), and thus with the number of nuclei of the stable isotope that underwent the nuclear reaction. It provides quantitative information in NAA.
- The measured in NAA–The quantity intended to be measured–is the total mass of a given element in a test portion of a sample of a given matrix in all Physico-chemical states. The quantity 'subject to measurement' is the number of disintegrating nuclei of a radionuclide. The measurement results in the number of counts in a given period of time, from which the disintegration rate and the number of disintegrating nuclei is calculated; the latter number is directly proportional to the number of nuclei of the stable isotope subject to the nuclear reaction, and thus to the number of nuclei of the element, which finally provides information on the mass and amount of substance of that element.

➢ APPLICATIONS OF NAA

It is very sensitive and is therefore used to analyse minor elements, which are present in low concentrations.

- Archaeology
    - Sourcing of clays and pottery
- Chemistry
    - Contaminants in salts, pure crystals, and metals
- Forensics
    - Analysis of Gun Shot residue and other crime scene materials (paint, glass, metals), Toxins, and trace elements in hair, skin, and nail samples

- Geology
    - Sourcing and composition of igneous rocks, sediments, and basalts
- Environment Studies
    - Detection of trace levels of various toxic metals such as mercury, uranium, and thorium
- Agriculture
    - Studying soil composition

EXAMPLE: A CASE OF CALIFORNIA

People v Woodward provides an example illustrating many of the considerations necessary to the proper use of NAA evidence.
•In response to a silent burglar alarm, the police arrived at the scene of an attempted burglary about 1a.m. and found the suspect Woodward not far from the door which a burglar attempted to open. Woodward said he had just happened by and was on the way to his car which was parked nearby.

•A tool used for changing tires was found several feet from the doorway. Upon inspection of Woodward's car, it was discovered that the tire tool was missing from the jack in his trunk and that the tool found near the doorway fit the jack; however, Woodward denied that the tool was his.

•Some specks of brown paint were found on the wedge end of the tire tool and a few specks of light blue paint were found adhering to the shaft. Visual comparison of the paints indicated that the brown specks resembled the paint on the doorway and the light-blue specks resembled that of Woodward's car.

•Other specks of light-blue paint were found on the floor of the car trunk, and because of the very small amounts of the paint on the tire tool NAA appeared to be the best method of chemical analysis.

<u>NAA ANALYSIS</u> - The brown paint on the tool was found to match the brown paint of the door in seven elements and the concentrations were the same within small statistical limits. The light blue paint on the tool similarly matched specks found in the trunk of Woodward's car, except that only five elements were detected in each.

- This evidence was presented at trial supported by a probability theory and the defendant was convicted.

➢ LIMITATIONS OF NAA

1. It is not a quick method and is often time-demanding and obtaining the results may take up to 2-4 weeks, depending on the half-lives of the elements (it may be longer or shorter).
2. It can only give information on total concentration of an element. No information of compound chemical structure and physical state can be immediately obtained.

3. Interferences may rise if different elements in the sample emit gamma rays of nearly the same energy.
4. Less common than other analytical techniques due to necessity of having access to a nuclear reactor or neutron generator.

➢ CONCLUSION

- Neutron activation analysis is one of the preferred techniques for quantitative analysis of different types of samples and has thus found wide application.
- It can perform non-destructive analysis on solids, liquids, suspensions, slurries, and gases with no or minimal preparation.
- It is a highly accurate method and can reliably be applied for the measurement of the concentration of elements at the trace level.

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INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2021-2022

COURSE: M.Sc. Forensic Science (Questioned Documents, Fingerprints and Forensic Physics)

SEMESTER: III

SUBJECT: PSFSQ302-Advanced Fingerprint Technology-I

TOPIC FOR PRESENTATION: Fingerprint Enhancement Techniques: Thermal Fingerprint Developer, Anti-Stoke Powder Imaging

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Introduction -

Fingerprints are a result of an anatomical manifestation of a pattern of ridges and furrows of the epidemic layer at the anterior aspect of the fingertips. This pattern is determined during the fetal development, and is believed to provide a unique signature for every individual and for each finger. Therefore, fingerprints constitute one of the most reliable bio metrics identification schemes, and are universally accepted as a legitimate proof of identity. Accordingly, fingerprints provide major evidence for forensic investigations and in criminal science. Additionally, they are used in contemporary security systems for access control.

In spite of the scientific developments done in the field of DNA profiling, fingerprints remains the best and a crucial form of evidence needed for personal identification in the arena of crime scene investigations. Fingerprint detection has improved significantly over the last 20 years due to concerted efforts by a number of research groups around the world. A wide range of optical, physical and chemical techniques is available for the detection and enhancement of latent finger marks. The best results are generally obtained if a logical sequence of techniques is applied. Also, in case of fingerprints the application of various techniques or chemical reagents may increases the number of latent prints detected thereby improving their quality and finally enhancing them. However, it is imperative that each process is applied in a systematic, predetermined order as the incorrect choice or application of one method can preclude the later use of another technique or lessen its effectiveness. During the procedure of the latent prints detection, the employing of optical techniques and procedures should be heavily emphasized as these are non-destructive in nature and considerably improves the results obtained by physical or chemical methods. Other techniques must be applied with caution, and developed prints recorded at each opportunity, as finger marks are fragile and readily destroyed.
The choice for the best detection techniques invariably depends on the circumstances from where the latent prints have been recovered and thus depends on a variety of factors, for example:

- The type of surface on which the latent print is present i.e. whether it is porous, nonporous, smooth or rough.
- Occurrence of any specific contaminant for example, blood.
- The probable age of the fingerprints; and lastly
- The environmental factors (e.g., whether or not the surface is or has been wet).

Thermal Fingerprint Developer -

Introduction -

Thermal development of fingermarks is a phenomena that was first observed as an fortuitous consequence of the exposure of paper items to heat, with the paper selectively darkening in the region where fingermark ridges were present.

This effect was most commonly observed close to the charred edges of burnt paper, where the mark had been exposed to high temperature but had not become highly discolored. It was also observed that even in situations where the paper had become charred over its entirety, fingermarks could still be detected by infrared photography.

In the market there are many thermal fingerprint developer but the Foster & Freeman TFD-2 and the Consolite Forensics Hot Print System (HPS) are widely in use, out of which TFD-2 is found to be used more frequently. Foster & Freeman were the pioneers in this field hence from here onwards TFD-2 and Foster & Freeman will be mentioned frequently but the things mentioned related to them will be applicable in general to the field of enhancement of fingerprint using thermal method.

Modern day development of Thermal Fingerprint Developer -

During the Southern California Association of Fingerprint Officers conference in Burbank, California in October 2009, two speakers on the platform were Adam G. Brown and Daniel Sommerville. Sponsored by Foster + Freeman Ltd., the speakers presented a research project they and their associates conducted at the University of Technology, Sydney's Centre for Forensic Science, in Sydney, Australia. The project involved the thermal development of latent fingerprints on porous surfaces.

In their review of the literature for their research, Brown, Sommerville, et al., found a section in the seminal text, Scott's Fingerprint Mechanics, that discusses the thermal development of latent prints and cites research done in the 1940s. The technique involved the application of heat by a typical clothes iron to a piece of paper. The heat will char the organic substances in the latent print residue and cause the latent print to become visible. The text explains, "As an intentional means of developing latent prints, heat is not a practical technique. Although heat cannot be considered a practical latent print development technique, a number of arson cases have been solved as a result of latent prints developed by heat." It was suggested that more predictable results could be obtained with the use of chemicals such as iodine and Ninhydrin.

Brown, Sommerville, et al., decided to revisit this discounted thermal development technique and determine whether they could develop more reliable and consistent outcomes. They also shared a personal humorous anecdote during their presentation: As they began to experiment with the application of heat to paper, they were causing smoke and fire alarms to go off in the lab to the consternation of university's administration. In the beginning, they applied heat to various paper substrates with thermal sources such as hair flat irons, hot-air guns, and furnaces.

The research team discovered that with the application of heat for short durations—before the paper becomes charred—the (still invisible) sebaceous or eccrine latent prints would fluoresce under forensic-light illumination at 505 nm and observed through a 450-nm barrier filter lens. They deduced that the conditions required for the thermal development of fingerprints are rapid heating in air to a temperature between 220° and 300°C. Heating at temperatures below 200°C for longer durations did not yield successful visible print development, while heating above 300°C appeared to be too rapid for latent print development and usually caused paper to become scorched or to ignite.
In conclusion, their research showed that eccrine-rich and sebaceous-rich latent print impressions on paper may be made visible on various paper substrates by the application of heat between 220° and 300°C and when observed under illumination in the 505 nm range of light. They claimed the thermal development of latent prints on paper and other surfaces has great potential as a simple, low-cost, chemical-free method for latent print detection and visualization, particularly in situations where development might not otherwise be attempted for reasons of time and expense.

Foster + Freeman became interested in the work of these researchers and began the commercial research and development of a thermal latent print developer for paper- or cellulose-based substrates. Today, they call their instrument the Thermal Fingerprint Developer, or TFD-2.

Foster + Freeman recently loaned the authors one of their TFD-2 units to experiment with for one week. The kit included the Foster + Freeman Crime-lite 82S Blue (495 nm) and 82S Blue/Green (530 nm). Their research was conducted with the TFD-2 kit at the Fremont (California) Police Department Crime Lab where author Nikoui is employed as the chief forensic specialist. They used the TFD-2 within the confines of a fume hood to vent any smoke created by our experimentation with this instrument.

Principle -

There is no particular theory regarding fingerprint development due to heat. The theory associated with thermal development on conventional paper substrates has not been conclusively established. Song et al. attribute thermal development to the presence of the fingermark locally changing the thermal properties of the paper, resulting in these regions heating more rapidly than the paper substrate and thus discolouring more rapidly by thermal degradation.

An alternative theory is proposed by Dominick et al., who ascribe the fluorescence and subsequent visual discoloration observed to the degradation of the amino acid constituents of the fingermarks.

The thermal degradation of amino acids in fingermarks has been studied, but the formation of fluorescent degradation products under the conditions used for thermal development has not been conclusively proven.

It is known that amino acids can bind to the cellulose molecules in paper; it may be the degradation products of these more complex structures that are ultimately responsible for the fluorescence observed. More research is required in this area.

The visualization of marks on thermal papers is attributable to the darkening of the active layer in the thermal paper. Whether this darkening is due to a heat initiated chemical reaction between the fingermark constituents and the chemicals in the active layer, or whether it is due to the presence of the fingermark concentrating the heat into the regions of the fingermark ridges and darkening the thermal layer, has not yet been established.

Effectiveness -

Thermal Fingerprint Developer is suitable on porous surface like paper, cardboard, currency note etc. The issue with the process is that it's efficiency varies and sometimes decreases according to the substrate under investigation. The method is not much useful for older prints which are more than a week old. Either the print is not developed or else the developed print is of no tangible use.

Procedure -

Procedure here mentioned is for TFD-2 but all other commercially available instruments also have almost the process based on their instrument functioning.

- Evidence is placed on the motor-driven conveyor tray and passed under an intense heating element.
- The heating element raises the temperature of the document and causes a chemical reaction between the latent fingerprint and the paper's surface.
- This produces a fluorescent byproduct that is visible with the use of a forensic light source in the range of 495 nm (blue) and 530 nm (blue/green).
- The user has complete control over the progress of development through variation of conveyor speed and heat-source intensity.

Advantages -

- Latent prints can be detected in seconds.
- There is no requirement of chemical processes.
- The virtually contact less system reduces risk of cross-contamination.
- High throughput reduces search times.
- Visible prints feature excellent ridge detail and contrast.
- Can be used sequentially with chemical treatments, including Ninhydrin and DFO.
- For use at crime scenes or in the laboratory.

Disadvantages -

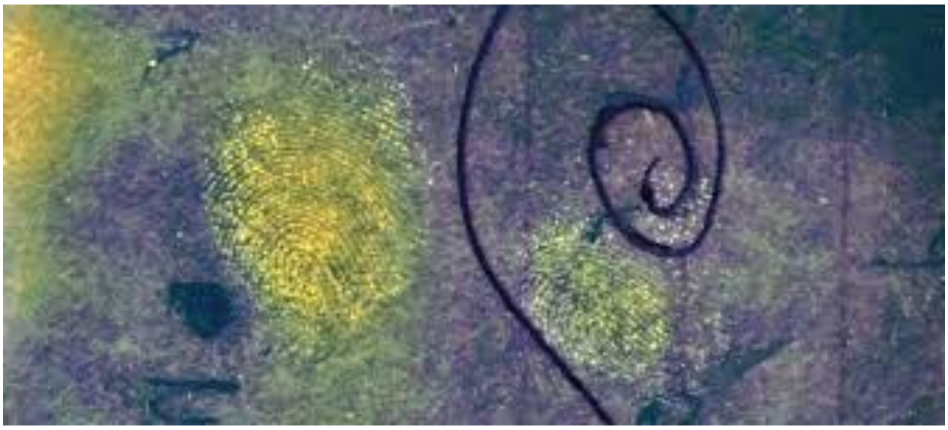
- Thermal development is not currently (2016) recommended as a Category A process in the Fingermark Visualization Manual because none of the commercially available systems have yet been sufficiently evaluated by the Centre for Applied Science and Technology (CAST) to give definitive advice about their operational use. Initial testing of the two commercially available systems (the Foster & Freeman TFD-2 and the Consolite Forensics HPS) indicates that, in general, as a single process they are less effective than the alternative chemical treatments that are available for paper/thermal paper.

- However, both processes can be conducted without the need to apply chemicals to the substrates. In the case of the development process for thermal papers, there is minimal impact on subsequent processes and it may be capable of visualizing sebaceous marks not found by amino acid reagents.

- The TFD-2 consists of a flat bed that holds the paper, this is then 'scanned' underneath an infrared heating element. The user can control both scan speed and the temperature of operation, thus varying the level of heat and the time that the item being treated is exposed to the heat.

TFD-2 by Foster & Freeman

Fingerprint developed using TFD-2



Fingerprint developed using TFD-2 under florescence

Anti Stoke Powder Imaging -

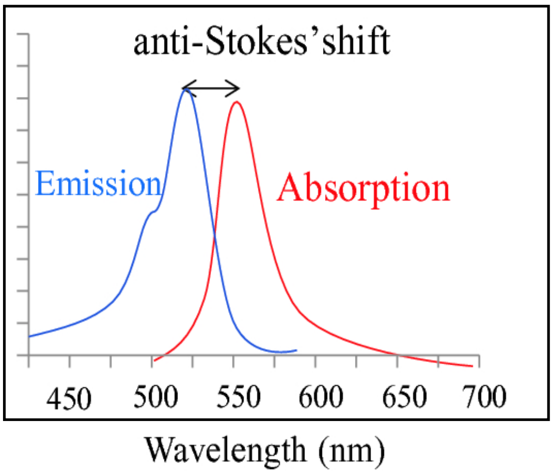
Introduction -

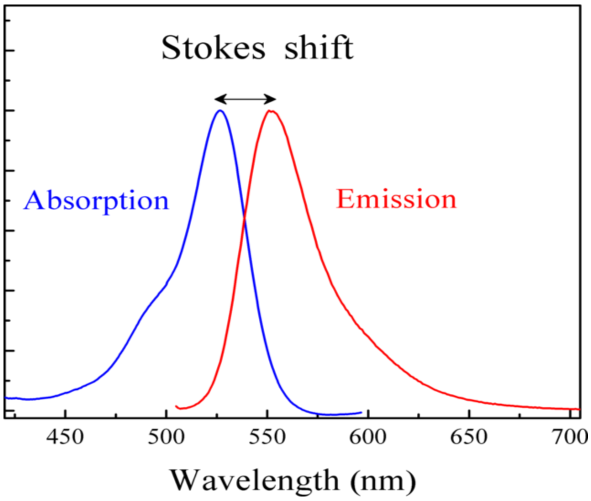
The Stokes shift is the term used to describe the difference in the wavelength at which a molecule emits light is relative to the wavelength at which the molecule was excited.

In simpler word when a system (be it a molecule or atom) absorbs a photon, it gains energy and enters an excited state. One way for the system to relax is to emit a photon, thus losing its energy (another method would be the loss of heat energy). When the emitted photon has less energy than the absorbed photon, this energy difference is the Stokes shift.

In the conventional fluorescence emission process, lower wavelength (higher energy) radiation is used to convert a material to its excited state. The material returns to its ground state by emitting a photon at a longer wavelength (lower energy). The difference in excitation and emission wavelengths is referred to as the Stokes shift. An example would be using the 514.5 nm line of an argon ion laser to excite Rhodamine 6G dye, which would emit at a maximum wavelength of approximately 555 nm.

When upconversion or anti stoke materials are excited with longer wavelength (lower energy) radiation sources like high-powered, near-infrared lasers, multiple photons can be absorbed. The emission of a single photon occurs at a shorter wavelength (higher energy). The difference in wavelengths is referred to as the anti-Stokes shift. Anti-Stokes Powders are comprised of specialized materials that exhibit upconversion or anti-Stokes emissions. An example of this was reported by Ma et al. who excited $NaYF_4$ doped with erbium and ytterbium at 980 nm and observed an emission in the green portion of the spectrum (495–570 nm) . The material produced good results on some difficult surfaces, including Australian polymer banknotes.





The primary advantage of using near-infrared excitation sources is that very few substrates absorb in that region of the spectrum. Thus, the excited substrates do not emit visible fluorescence that could compete with that emanating from the anti-Stokes-powdered print. For example, when a Coca Cola can is illuminated with green light, the red-colored back-ground luminescence strongly. When illuminated at 980 nm, the same background emits little or no background fluorescence. Although still a very recent development in latent print visualization field, these upconversion materials were studied extensively by Elicia Bullock, a student at the University of Technology, Sydney, Australia.

Anti-Stokes Visualization -

When latent fingerprints are located on material with multi-coloured backgrounds, standard treatments may not produce clear prints because of background interference. Even standard fluorescent powders and stains may fail if the background itself fluoresces. Treatment with the new anti-Stokes powders can overcome this problem. As these powders produce visible fluorescence when illuminated with invisible near infrared light, latent prints that have adsorbed the powder can be seen while the background, reflecting only infrared light remains invisible - rendering the latent prints clear of background interference.

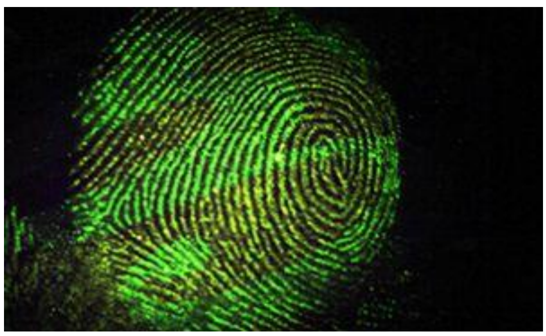
Crime-lite® ASV -

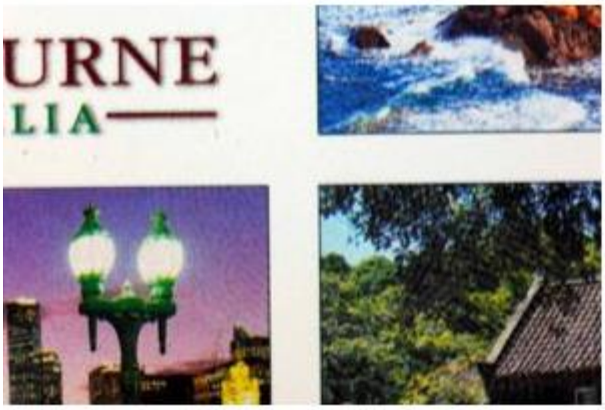
Crime-lite ASV bench-mounted system for the examination of latent fingerprints treated with anti-Stokes fingerprint powders stimulated by IR laser. A bench-mounted Class 1 laser viewing enclosure for the stimulation of infrared activated anti-Stokes fingerprint dusting powders, the Crime-lite ASV renders high contrast fingerprints with no background interference. Anti-Stokes powders, also known as up-convertors, are a relatively new form of fingerprint powder that absorb invisible infrared radiation and re-emit the energy at visible wavelengths, a process that is the reverse of standard Stokes-shifted fluorescence. Excellent results can be obtained with fingerprints on 'busy' multi-coloured backgrounds and on backgrounds which fluoresce at similar wavelengths to standard fingerprint treatments. It uses an anti stoke magnetic powder for visualization applied using a magnetic applicator. It has Safety-interlocked Class 1 laser viewing enclosure two 6 Watt lasers, laser illumination area and laser blocking fingerprint viewing/imaging window.

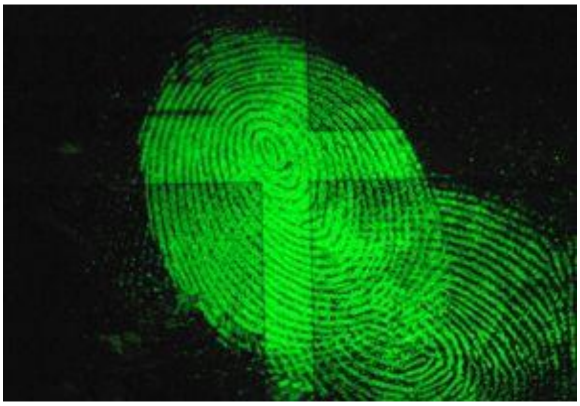
Application -

- Paper and card including banknotes, passports, magazines etc.
- Smooth metal surfaces including drinks cans.
- Electronics items such as mobile phones, laptop tablets etc.
- Firearms, that require test firing following treatment.

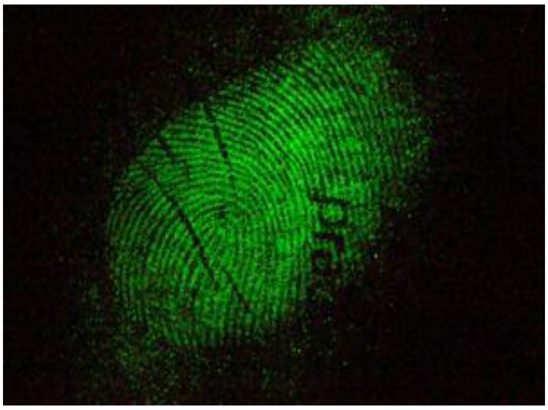
Drinks can







Postcard



Glossy magazine

Advantages -

- Bright visualization of fingerprints under infrared illumination
- Minimize the impact of background fluorescence
- It's safe to use no harmful effect is observed.

Disadvantages -

- The method would not work on substrate that absorbs light of longer wavelength.
- It's a new field that has open up for fingerprint detection and hence requires a lot more research.
- It's an expensive technique and require elaborate instruments and different expensive powder for visualization.

Conclusion -

Fingerprint enhancement techniques are a requirement of the new age where courts are giving so much importance on evidences. The developed fingerprint if can be enhanced gives law enforcement extra teeth for investigation and helps courts to make an informed decision. There are many methods for fingerprint enhancement but thermal fingerprint development and anti stoke powder imaging are coming up avenues in this field. Both these techniques are non destructive nature which gives investigator an advantage that they can use some other method if required. There is a lot research that needs to be done for both thermal fingerprint developer and anti stoke powder as how they work and many other aspect related to them. These are upcoming techniques and with more research on them we can expect them to become common among law enforcement agencies around the world.

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INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2021-2022

COURSE:M.Sc. FORENSIC SCIENCE (QUESTIONED DOCUMENTS, FINGERPRINTS AND FORENSIC PHYSICS)

SEMESTER: IV

SUBJECT: PHYSICAL EVIDENCE EXAMINATION

TOPIC FOR PRESENTATION: RAILWAY ACCIDENTS

PRESENTED BY: PRIYANKA MARUTI BASUTKAR

ROLL NO: 02

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RAILWAY ACCIDENTS

Rail Accident means accident occurring on account of collision between trains or collision of trains against external objects, or derailment of train resulting in bodily injury

A train accident can be devastating incident resulting in serious injury or even death to the victims involved. Whether it is a derailment, a train vehicle collision, a railroad crossing, an accident involving hazardous materials, or any other type of railroad accident, many people may be harmed.

TYPES OF TRAIN ACCIDENTS

- Derailments.
- Train-Train Collisions.
- Train-Vehicle Collisions.
- Train-Bicycle Collisions.
- Train-Pedestrian Collisions.

Causes of Train & Railroad Accidents

There are a variety of reasons why train accidents occur – most of which take place at crossings when cars try to "beat" the train. When these accidents occur, they often involve the passengers, driver, and some passersby.

While every case is unique, the most common causes of train accidents include:

- Negligence
- Human error
- Reckless pedestrians and drivers
- Mechanical failure
- Speedy trains

- Defective tracks
- Derailments
- Unprotected railroad crossings
- Stalled cars on the track
- Suicides

1. Negligence

Railroad accidents due to negligence can be blamed on different groups. Some may be the fault of the railway company itself, whereas others are because a conductor or railroad employee was negligent. Some accidents are even caused by the neglect of a government agency. Or perhaps an equipment manufacturer can be a reason why the accident happened.

One example of railway negligence is when a crossing arm is operated incorrectly. Another careless mistake is if the operator forgot or failed to turn on the signal light, which should have provided adequate warning.

A common factor that contributes to this problem is the decades old, outdated technology still frequently used for railways and trains today. Better technology is available to improve railway safety, but adopting these features is often put on hold because it involves a hefty investment.

For example, all Class I main lines that handle either hazardous materials or passenger trains (or both) were required by Congress to implement a system of train control technology called Positive Train Control (PTC) by the end of 2018. PTC aims to prevent many different types of train accidents such as collisions between trains, grade crossing accidents, and train derailments due to high speeds. However, an estimated two-thirds of U.S. commuter railroads failed to meet the deadline, and PTC is only in operation on 45% of tracks owned by freight railroads and 24% of tracks owned by passenger railways.

2. Human Error

If the conductor is inexperienced, train accidents can easily happen. Even those who have been working in the railroad industry for quite some time may make a mistake that harms other people, including passengers. Another growing problem with both experienced and new conductors is fatigue. They cannot operate the train safely if they’re exhausted, yet they do so anyway due to pressure they face from their supervisors and company.

Human error has always been one of the most common reasons for any accident. From poor judgment to vision issues to impaired reactions, these factors can (and do) contribute to train disasters.

3. Reckless Pedestrians & Drivers

Train accidents aren't always the fault of the train operator or company. Sometimes, a reckless or distracted pedestrian can cause a collision by standing on or crossing the tracks at the wrong time. In other scenarios, the driver of a car, truck, motorcycle or other motor vehicle can cause an accident by leaving their vehicle parked on a train track or trying to beat the train across a crossing.

4. Mechanical Failure

The train operator, railway employees and the company itself can do everything within their ability to follow all the required safety procedures, but a train accident can still happen. Mechanical failure and defective parts are more rare than other common causes of train collisions, but they do occasionally happen.

Trains are large machines with complex systems and many moving parts. All of the different systems must work together perfectly to provide locomotive and electric power. If some piece of guidance equipment (such as a rail switch) or safety equipment (such as a rail signal) fails, it can cause a deadly accident.

5. Speedy Trains

Time and again, car accident data proves that driving recklessly fast can lead to serious injuries and deaths. Trains are no exception. Many train accidents in recent years showed that the faster the train, the worse the consequences become in the event of a crash and the higher likelihood of derailment.

6. Defective Tracks

Obstruction is a common issue with the tracks and can cause train derailment. Foreign objects left inadvertently at the site where the train will pass can be deadly. Conductors should be aware of their surroundings at all times to manage a potentially dangerous situation quickly and safely. However, in some cases, a conductor fails to see these obstacles at all or in time to stop a collision.

7. Derailments

A derailment is when a train runs off its rail, either because of a collision with another object, a conductor error, mechanical track failure, broken rails, or defective wheels. A derailment doesn't necessarily mean the train leaves the tracks – some may be minor. However, a serious derailment can be catastrophic if it occurs while the train is moving at a high rate of speed.

8. Unprotected railroad crossings

More than 80 percent of crossings lack adequate warning devices such as lights and gates, and more than half of all railroad accidents occur at unprotected crossings. Tennessee residents know well that there are many unprotected railroad crossings across the state. Accidents at unprotected railroad crossings are most often caused by:

- Poor visibility
- Driver distraction
- Driver inebriation/intoxication
- Driver trying to race the train

  - Malfunctioning signals
  - Obstacles that block a driver's view
  - Conductor failing to sound an alarm

9. Stalled cars on the track

Cars rarely get stuck on railroad grade crossings. More common is when drivers stall out when slowing down to cross bumpy grades due to a poorly tuned engine. If this happens to you, first you try to start it again immediately. If it won't start, put your vehicle in neutral and ask for help to push your vehicle off the tracks. But if a train is rapidly approaching and there’s no time to save your car, remember that your life and safety are first priority. Get as far from your vehicle as possible.

10. Suicides

Sadly, some people choose to take their own lives by standing on the tracks or jumping in front of a train. Federal statistics show that 266 people killed themselves by stepping in front of trains in 2017. Unfortunately, this tragic and desperate act also endangers other lives such as train crews, emergency responders, passengers and bystanders.

How to Prevent Railway Accidents

Trains typically weigh between 80,000 and 400,000 pounds, and the last thing any of us want is to collide with one of them at a high speed. Here are some tips for preventing railway accidents:

- ✓ Always be on the lookout for warning signs and signals when approaching a railroad crossing;
- ✓ Always assume that a train could approach at any time;
- ✓ Whether you are walking, biking, or driving, only cross railroad tracks at designated crossing areas, and never walk on or alongside the tracks;
- ✓ Always look both ways before crossing a railroad track;
- ✓ Be aware that trains cannot stop quickly, and never try to beat a train across the tracks;
- ✓ Never stop your vehicle on top of a track, and if your vehicle stalls, get out of it immediately;
- ✓ Never, under any circumstances, attempt to board a moving train.

CASE STUDY

This study shows the preliminary systematic analysis of several Pune rail accidents of central railway as well as local railway bogies, i.e. those at Pune Junction platform and on the tracks which run within the limits of Pune municipal corporation.

INTRODUCTION

- Pune is an important city as well as an industrial town and an educational centre of Maharashtra where large number of people migrate for the purpose of securing quality education.

- Pune Junction Railway Station is the main railway station of Pune. It is a railway junction on the Mumbai-Chennai line and the Pune-Bengaluru line starts from here.
- This railway junction has six platforms and eight tracks.
- The Pune Railway Station serves as a stop for southbound trains from Mumbai, Gujarat, Madhya Pradesh and Rajasthan and it also forms a stop for northbound trains from Karnataka and Goa.
- The Pune suburban railway runs on two major routes, Pune junction to Lonavla and Pune junction to Talegaon.
- There are three trains that run on Pune-Talegaon route and 15 trains that run on Pune-Lonavla route.
- Important stations on these routes are Shivajinagar, Khadki, Pimpri, Chinchwad, Akurdi, Dehu Road, Talegaon and Lonavla. On an average nearly 1,50,000passengers travel through these routes every day.
- Thus with an increase in the growth of population in the city there is an increase in passenger traffic which leads to the increase of railway accidents and fatalities. The Pune railway station has 6 platforms and on average 286 trains run on this platform.

METHODOLOGY

The study of the railway accidents in the previous ten years has been done from the data which is obtained from the sources like the Pune Division Railway Manager, Public Information Officer of Central Railway Department, Police papers and records, and from the Newspapers. This data was provided under the Right to Information Act, 2005. On the basis of this information and other sources a statistics of the accidents patterns, their number and causes are illustrated which gives us the foundation errors in the railway industry and lead us to the necessary actions which should be taken to reduce these accidents. The data is analyzed by the respective department and is recorded for public welfare and information.

OBSERVATIONS

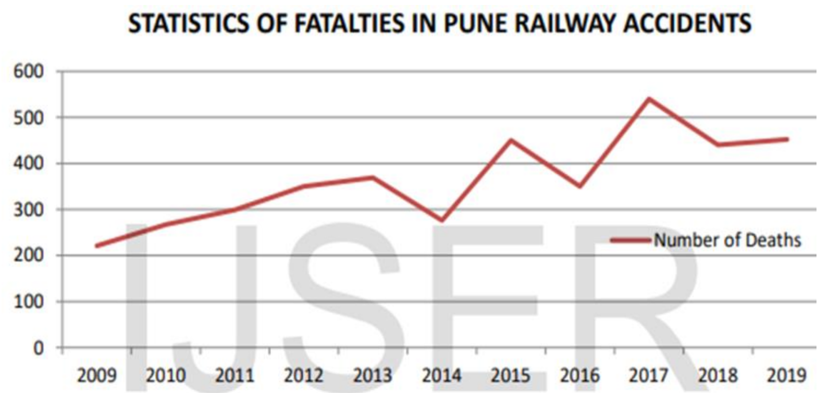
The Accidental prone areas of Pune are Pimpri, Chinchwad, Akurdi, Ghorpuri, Shivajinagar and Khadaki.

In most of the cases passengers lost their lives due to having an imbalance while jumping into a running train.

Some passengers, nearly 2 percent of the total fatalities were due to getting stuck between the gap provided between the track and platform.

In 2009, the total number of individuals loosing their lives on track was 221. In 2016, this number raised to 350. This number of deaths was very high in the year 2015 having 450 deaths.

The total number of deaths observed from March 2017 to March 2018 is 540 which is the maximum till date. In the month of July 2018, 49 people died on track and this number has reached to 330 till the end of December 2018 and at theend of March 2018 this number reached 440.



Type of accidents was mostly due to run over or knockdown by trains while crossing the track and also due to falling down from running trains.

The main cause of such accidents is avoiding the use of foot over bridges and using shortcuts while crossing the railway track negligently.

Other reason is that some passengers directly board on the running train and deboard from running trains due to which they often lose their balance and result into severe injuries and also death.

Year	Total number of deaths occurred on Pune Railway Station	
	On the Track	Near the Platform
2014	27	6
2015	29	9
2016	31	9
2017	31	9
2018	23	4
2019 (upto February)	3	3

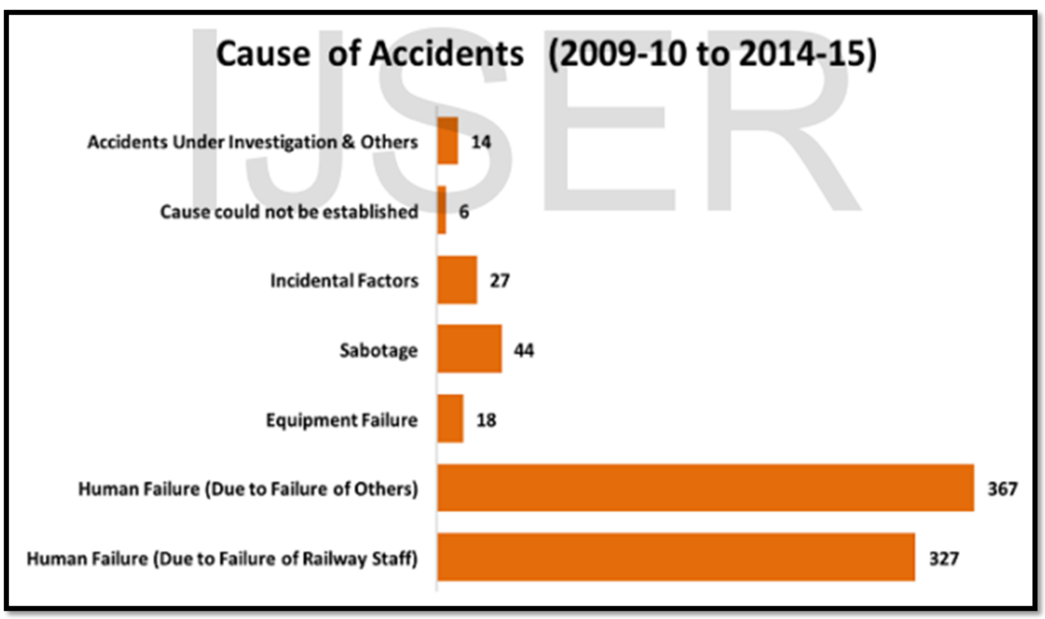
The different type of accidents in railway are due to derailment, collisions, level crossing accidents, fire in train accident, as well as misc. accidents which include some personal errors and suicides.

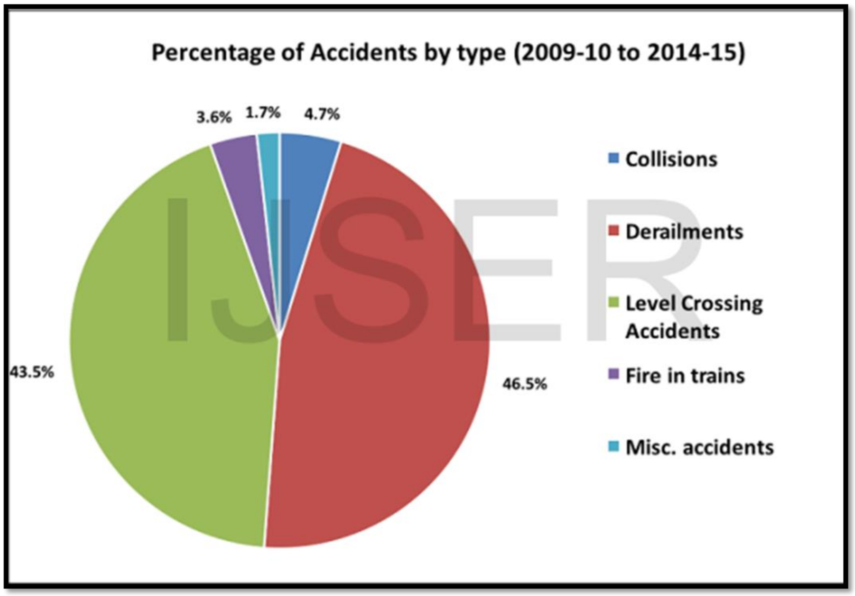
Followed by accidents at level crossings where people often disobey the gate signal and rush on the track.

The other causes of accidents account for very less percentage, i.e. less than 5% for collisions, fire in trains and misc accidents.

Thousands of passengers commute from Lonavla, TalegaonDabhade, Chinchwad and other stations to Pune.

As per the officials there are four local trains which are operating between Pune and Lonavla. These tracks are more than 40 years old so there is a need to replace or repair these tracks to avoid further derailment of trains.





CONCLUSION

From the data which is collected, it is observed that the majority of the cases of the accidents are due to derailment and level crossings.

To reduce these accidents regular maintenance of tracks should be done by the contractors under the Pune Railway Division.

Instead of manually inspecting tracks as carried in the past, the track maintenance should be automated by using derailment detection devices.

Another alternative for reducing the accidents in collision and level crossing is the Rail Traffic Control.

Speed Monitoring and Contol is another important measure for Railway safety.

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INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2021-2022

COURSE: M.Sc. FORENSIC SCIENCE (QUESTIONED DOCUMENTS, FINGERPRINTS AND FORENSIC PHYSICS)

SEMESTER: 03

SUBJECT: PSFSQ302-Advanced Fingerprint Technology-I

TOPIC FOR PRESENTATION: Fingerprint fuming systems and desiccated remains

PRESENTED BY: SHRUTEE CHAVAN

DESICCATED REMAINS

INTRODUCTION:

Fingerprinting has long been used as a method for identifying bodies and, since first discovered, many advances have been made in both fingerprint acquisition and interpretation. However, in the field of forensic pathology, the attainment of fingerprints from mummified bodies has remained difficult. Unlike antemortem fingerprint processing, each case of postmortem fingerprint processing may require a unique combination of basic and advanced techniques due to the unique set of circumstances surrounding an individual's death. The condition of the friction ridge skin on each finger will dictate which method must be used to successfully enhance and record any valuable friction ridge information; multiple techniques may be used on each finger and can differ considerably.

The most common technique historically used to obtain fingerprints in these cases usually employs the amputation of the fingers combined with soaking and/or injecting the fingers with various solutions in order to enhance the fingerprints. A novel approach to fingerprinting mummified fingers is presented which involves removal and rehydration of the fingerpads (including the epidermal, dermal, and adipose tissues) followed by inking and rolling, using a gloved finger for support. The technique presented produces a superior quality of print without amputation of the finger, yielding excellent results and assisting in obtaining positive identification.

1. MACRO PHOTOGRAPHY/MICROSCOPE TECHNIQUES

Prior to using any techniques that may deteriorate the friction ridge skin, any visible friction ridge detail should be photographed. This can be achieved through digital photography. Use of a digital single lens reflex (DSLR) camera with macro lens, mounted on a copy stand, is the preferred method, as the camera is portable and the field of view is adjustable. Alternatively, if the friction ridge detail being photographed is separate from the remains (i.e. castings, skin, fingers, etc.) a dissection microscope with digital camera attachment can also be used. However, the microscope is not as portable as the DSLR camera and the field of view may be much more limited. The appearance of ridge detail can be further enhanced with the appropriate selection of direct, reflected, oblique, or transmitted lighting. Duel gooseneck lighting can provide the direct and oblique lighting, while a portable X-ray film illuminator viewer can provide the transmitted lighting. In addition, an alternate light source (ALS) can be used for more advanced photography of the fingerprint impressions (Marin & Buszka, 2013). It is also crucial to capture the images of friction ridge skin at 1:1, since the photographs will be compared to antemortem impressions of the same size.

2. CASTING TECHNIQUE

The casting technique is an advanced recording technique used as an alternative transfer medium to the adhesive lifters used during the powder, acetate, and lifter technique. The casting technique is very useful when working with a decedent exhibiting desiccation and mummification, where the friction ridge skin is hard, significantly dry, and is not pliable. The casting technique can also be used after the rehydration technique. In addition, it can be used during a mass fatality incident when fingerprints need to be recovered rapidly and the rehydration method is not an option. During postmortem changes, excessive drying of the skin leads to multiple depressions within the friction ridge skin that cannot be flattened. Application of adhesive lifters will not capture the friction ridge information within the depressions. Since the casting material is very pliable at the time of application, it will capture friction ridge information that is available on a flat surface, as well as within any depressions. This process creates a threedimensional fingerprint impression that can be flattened into a two dimensional fingerprint impression, scanned or photographed, and then searched similar to fingerprint impressions created using the inktransfer technique or the powder, acetate, and lifter technique. Mikrosils and Accutranss are silicone-casting compounds often used for capturing tool mark impressions and latent prints at crime scenes, but are now commonly used for postmortem fingerprint acquisition. The decedent's fingers should be separated to avoid the castings from touching one another and sticking together. This can be achieved by weaving paper towels or tech wipes between the fingers. A small amount of black fingerprint powder is deposited onto a weigh boat (or small shallow container) and a fingerprint brush (or foam paint brush) is lightly brushed against the powder. The decedent's dry fingers are then coated lightly with fingerprint powder and casting material is then applied. Mikrosils requires a two-part formulation: one tube is larger, has the consistency of toothpaste, and contains the base material; the smaller tube contains a blue-colored catalyst, which hardens the base material when both are mixed with one another. An approximately 2" strip of base material is squeezed onto a weight boat, followed by an approximately 1.5" strip of the blue catalyst. A wooden spatula or tongue depressor can be used to mix the two components together for about twenty to thirty seconds until the color of the blue catalyst is no longer visible in the base material. The mixing time must be kept to a minimum, since the material begins to harden after about thirty seconds. Accutranss is a polyvinylsiloxaine casting agent that also requires a two-part formulation; however, the product is in the form of an automix gun that allows direct application to the fingers using a spreader tip. The casting material is immediately applied to the powdered finger. It is best to apply the casting material in one smooth "swipe" from one side of the finger to another. Once contact occurs, the rest of the casting material can be lightly applied against the rest of the finger with the spatula. It is best to apply a thin coat so the resulting hardened casting can be flattened and captured as a two-dimensional image. The casting material should be left on the fingers for approximately ten to fifteen minutes. Once the material has dried, the fingerprint casting is then slowly lifted to reveal a "high contrast, highly detailed, three-dimensional mold" (Tomboc & Shrader, 2005). The casting can be placed onto the corresponding area on the backside of a clear acetate fingerprint card or placed into a small, resealable clear plastic bag and marked accordingly.

When the skin is severely damaged and there is limited friction ridge detail visualized on the white castings, fluorescent powder—such as Greenwop powder—and black casting material can be used. Greenwop powder fluoresces under ultraviolet light, so the resulting castings can be photographed under ultraviolet lighting (Tomboc & Schrader, 2005).

If another fluorescent powder is used, the castings can be photographed using an alternate light source. If the resulting castings continue to display low-examination quality friction ridge detail, the soaking and rehydration method should be used. Once the skin is rehydrated and pliable, the casting method should be attempted again to record examination-quality fingerprint impressions.

3. BOILING TECHNIQUE

In some cases of advanced decomposition, friction ridge detail may not be detected because the top layers of friction ridge skin may already be completely destroyed. In these instances, the layer of the friction ridge skin underneath the epidermis, known as the dermis, may reveal discernible friction ridge detail and can be recorded or photographed successfully. The Boiling Technique is an advanced fingerprint recovery technique used when working with a decedent exhibiting severe decomposition and putrefaction, in which the epidermal layer of friction ridge skin has been destroyed and only the dermal layer remains. The fingerprint technician may at first see little or no discernible friction ridge detail and must exercise significant care when handling dermal skin, as it is the last layer of friction ridge information left that cannot be recovered if it is destroyed. Any visible ridge detail should be photographed prior to using this technique, which may further deteriorate the friction skin. The recorded dermal fingerprint impressions will appear differently than epidermal fingerprint impressions because the dermal impression will exhibit a double fine line created by the dermal papillae. When compared to the epidermal impression, each double row of dermal papillae represents a single epidermal ridge. There are also instances when the epidermis is only partially sloughing off and parts of the dermis are exposed. The dermal ridge appears as a double fine line wherever it meets the single fine line of the epidermal ridge.

Fingerprints from the dermis can be recovered by using the Boiling Technique, a method that involves the use of boiling water to enhance ridge detail in the dermal skin through the process of osmotic rehydration (Uhle & Leas, 2007). The hands will be soft, pliable, and the ridges of the dermis will appear flat. Water is brought to a boil just below boiling point and maintained at this temperature in an electric hot water kettle or metal pot coupled with a hotplate. The container with boiling water is unplugged or taken off the heat source and the decedent’s hand or fingers are carefully submerged in the hot water for five to ten seconds. It is best to lower the friction ridge being processed into the hot water source, as opposed to moving the hot water source, as this may be dangerous and cause the hot water to spill. The hand should slowly be removed from the water and inspected for dermal friction ridge detail, which will be visible if the hot water has plumped the dermal skin. If no discernible ridge detail is visualized, the hand should be placed back into the water for another five to ten seconds. A shorter time may be needed when severe decomposition or fine ridge detail is present. A longer time may be necessary during other circumstances; the process should be repeated for no more than thirty seconds total. In the event the friction ridge detail contains any sort of trauma, such as defects or abrasions, hot water application should be avoided in these areas, as they will be enhanced by the hot water as well. An alternative method is to indirectly apply the hot water to any undamaged areas of friction ridge skin. A sponge or foam paintbrush can be used to apply the hot water and avoid any defects that may obscure reconditioned ridge detail. Once the dermal ridge detail is enhanced, the raised detail is carefully cleaned with tech wipes, paper towels, or a soft-bristled toothbrush and warm water. The skin should be brushed in the direction of ridge flow. The skin is then blotted dry with isopropyl alcohol and paper towels or by using a blow dryer on the warm setting. Once the skin is dry and there is visible friction ridge detail, it can be recorded using one of the basic fingerprint recovery techniques. The recorded dermal fingerprint impressions will exhibit significantly more ridge detail after using the Boiling Technique.

4. REHYDRATION TECHNIQUE

Note: Depending on the jurisdiction, there may be restrictions on removing the decedent's fingers and advanced approval may be required from the medical examiner.

When desiccation or charring of the remains occurs, the friction ridge skin is dehydrated and the tissue shrinks, resulting in wrinkled and very tough skin. This severe damage of the friction ridge skin is the most difficult and time-consuming to recondition. Often, the body also exhibits rigor mortis, which results in clenched fists and difficulty accessing the friction ridge detail. When this occurs and rigor mortis cannot be overcome by forcefully straightening the fingers, the fingers may need to be removed from the hand in order to access and recondition the friction ridges. Before removing the fingers, it is important to have paper towels or tech wipes set up and marked with each finger, as well as labeled containers for each of the respective fingers that will be amputated. Amputation of desiccated fingers is best achieved by using 27-inch loppers, which have a 2-inch cutting capacity. The fingers should be removed one at a time to avoid confusion. The lopper blades should be positioned over the proximal phalange, just above the knuckle area. If the lopper blades do not amputate the finger easily, scissors or a scalpel can be used to cut through any remaining tissue in order to completely separate the finger from the hand. The fingers can be transferred into their respectively labeled containers as they are removed. The fingerprint technician should assess each amputated finger; this can be achieved by taking each finger out of its container with forceps and placing it under a magnifying glass to look for friction ridges. After examination of the amputated fingers, if visible ridge detail is present, photographs should be taken prior to using the Rehydration Technique, which may further deteriorate or destroy the friction skin. Additionally, the Casting Technique may be attempted at the examiner's discretion. If the Casting Technique is not successful, the fingers can be placed into labeled sealable containers, such as urine specimen cups or conical tubes and filled with rehydration solution. Various soaking solutions can be used for the Rehydration Technique, such as liquid soap1, bath wash, and Dodge Metaflows. In addition, different chemical methods for rehydrating postmortem friction ridge skin have been published, such as soaking the fingers in 1% to 3% sodium or potassium hydroxide (FBI, 1979) or in the leather conditioner Lexols (Uhle, 2010). Additionally, the bromine injection method, uses various concentrations of bromine and alcohol injected under the skin to rehydrate epidermal friction ridge skin, resulting in the successful creation of legible fingerprints (Mulawka, 2008). The San Diego County Medical Examiner's Office uses a 50/50 solution of Dodge Metaflows and Dodge Restoratives embalming fluids (Mulawka, 2008). Another rehydration method is the Ruffner Rehydration technique, which uses a mixture of sodium carbonate, ethanol, and water to rehydrate the post-mortem desiccated fingers (Schmidt, et al. 2000). Many of these chemical techniques are labor intensive and require the use of uncommon and costly materials, including chemicals and detergents that may destroy tissues. As such, the author's preferred method is to use liquid soap or bath wash for rehydration solutions, because both are very cost-effective and the least labor-intensive rehydration methods. The bath wash has been found to be the most effective and most rapid rehydration method because it serves as a detergent and moisturizer for the skin. The liquid soap or bath wash can be diluted with warm water. Each container should be filled with enough solution to cover the ridge detail completely. The containers are sealed and stored in a secure location at room temperature for at least 24 hours. Finger rehydration may take hours or days due to the unique circumstances of each case and extent of desiccation. As there is no set time frame or when the skin will become pliable, the fingerprint examiner must regularly check the fingers for skin pliability, preferably daily. If the fingers are left in solution for too long, the friction ridge may be destroyed and unrecoverable. When checking the fingers to determine pliability, the skin should start to give slightly under pressure when it is ready. Some of the solutions are potentially destructive to the friction ridge skin and may cause some shedding of the epidermal layer of friction ridge skin. Since the outer layers may shed, they can be further removed by gently brushing the skin with a soft-bristled toothbrush under warm running water. The skin should be brushed in the direction of ridge flow. The epidermis should appear white and soft at this point. Once the skin is pliable and there is visible friction ridge detail with no depressions, it can be recorded using one of the basic fingerprint recovery techniques. If the skin exhibits depressions, the Putty or Casting Techniques should be attempted. If the aforementioned methods are unsuccessful but the skin remains pliable, the fingers may require the Injection Technique.

If the entire epidermal layer has sloughed off, the Boiling Technique may be necessary and the examiner must use discretion, as this may further deteriorate the already fragile friction ridge skin. The finger can also be photographed under a dissection microscope, DSLR camera with macro lens or coupled with oblique lighting. Once the fingerprint impression is recorded from the skin, it should be placed in the respective labelled container and returned back with the remains.

5. MOISTURIZER TECHNIQUE

If the friction ridge skin is dehydrated but remains pliable, the lessinvasive Moisturizer Technique3 can be used. This method involves application of a moisturizing bath wash to the friction ridge detail on the fingers. The solution should be massaged into the fingers and cover all of the ridge detail that will be used for recording. Sealable biohazard bags or sealable plastic bags are then placed over the hands and tied at the wrist using string, zipties, or rubber bands. The hands should remain in the plastic for a few hours and checked periodically for pliability. The skin should start to give slightly under pressure when it is ready. Once the skin is pliable and there is visible friction ridge detail with no depressions, it can be recorded using one of the basic fingerprint recovery techniques. If the skin exhibits depressions, the Putty or Casting Techniques should be attempted. If the aforementioned methods are unsuccessful but the skin remains pliable, the fingers may require the Injection Technique. The finger can also be photographed using a DSLR camera with macro lens and external flash. The Moisturizer Technique has been found to be the most effective, rapid, least-invasive, and least-destructive rehydration method because it serves as a detergent and moisturizer for the skin.

If the friction ridge skin is too brittle to attempt the previously described methods, the underside of the friction ridge skin may be photographed. To accomplish this, "it may be advisable to trim the skin, flatten it out between two pieces of glass, and photograph it in that position" (FBI, 1979, p 144). The skin is trimmed by carefully and meticulously removing the excess flesh by scraping, cutting, and trimming until only the friction ridge skin remains and can be flattened satisfactorily between two pieces of glass. Another method to further enhance friction ridge detail is to use transmitted lighting. This is accomplished by shining a light through the skin toward the lens of the camera when photographing. If the skin is still not transparent enough, soaking the skin in xylene for approximately five minutes before photographing or keeping the skin immersed in xylene while photographing is recommended. Once a suitable photograph is obtained, the negative may be printed as necessary to provide correct orientation of the impression for subsequent comparison to known standards.

Recording Desiccated Friction Ridge Skin

Traditional methods to obtain recordings of friction ridge detail from desiccated skin usually involve removing the hands or feet and subjecting the skin to many hours of potentially destructive chemical rehydration soaking and softening techniques. Although these methods work well to rehydrate the friction ridge skin, and will be discussed in further detail, a much less destructive and time-consuming method is available. This method involves the use of a silicone product (Mikrosil) to successfully record friction ridge detail that has been subjected to various types of destructive conditions such as desiccation, hardening, or wrinkling. Removal of the hands or feet is not always necessary, and this procedure may be accomplished at the mortuary or morgue.

To begin, the friction ridge skin must be cleaned and dried. The fingers should be separated to keep the silicone casts from sticking together. A light coat of black fingerprint powder is applied with a soft fingerprint brush to the friction ridges. The casting material is then mixed according to the included instructions and applied to each finger or other areas of friction ridge skin. After approximately 15 minutes, the casts are peeled off one at a time and marked accordingly, thus revealing a "high contrast, highly detailed, three-dimensional mold" (Tomboc and Schrader, 2005, p 473). These silicone casts may then be photographed and preserved. When the casts are examined, the friction ridge details will be black and will be in the same orientation as if they had been recorded on a fingerprint or palmprint card. On severely damaged or decomposed friction ridge skin, Greenwop powder, which fluoresces under ultraviolet light, and black casting material may also be used. The resulting casts are then photographed using ultraviolet light (Tomboc and Schrader, 2005, p 474). If this method should fail to produce discernible friction ridge detail, the traditional methods of rehydration and softening must be implemented. Once the skin is rehydrated and softened, the Mikrosil method may be used subsequent to the traditional methods to facilitate satisfactory recordings of any restored friction ridge detail.

Rehydration of the prints is accomplished by massaging the removed fingerpad under warm running water. This step takes approximately 10–15 min in most cases. Gently massage the pad to ensure full rehydration by carefully rolling the finger pad between your fingers such that the inner surface is the subcutaneous tissue

Re-Rehydration: If you find that the print still has ridges or is otherwise inadequate, return it to the warm water and massage it for a few more minutes. The print will begin to harden, dry out quickly after it is removed from the water and may require multiple rehydration steps in order to achieve the desired outcome.

FUMING SYSTEMS

There are several other ways in which vapour phase processes can be used to enhance fingermarks. In a review of techniques for development of latent marks, Micik (1974) listed three fuming techniques: iodine, hydrogen fluoride (for etching fingermarks on glass) and the burning of substances including camphor and magnesium to produce fumes that selectively deposit particles on fingermark ridges.

1. Iodine Fuming

The iodine fuming technique has been used for latent print development for at least a century. Several variations of the fuming procedure have been proposed over the years. The mechanism of the iodine fuming reaction was initially thought to involve the reversible addition of iodine to the double bonds of the unsaturated fatty acids in fingerprint residue by the process of halogenation. More recent research by Almog, Sasson, and Anah suggests that the mechanism of interaction involves physical absorption rather than a chemical reaction. When iodine crystals are warmed, they produce a violet iodine vapor by sublimation. The iodine fumes are absorbed by the fingerprint secretion residues to give yellowish brown latent prints. The iodine color is not stable, however, and is short-lived unless the iodine is chemically fixed.

Iodine Fuming Cabinet Method:

1. Suspend specimens or articles to be treated in the upper portion of the fuming cabinet.
2. Place approximately 1 g iodine crystals in a clean evaporating dish in the cabinet.
3. Close the fuming cabinet door.
4. Heat the iodine crystals slowly and gently to about 50°C with a heating block or other appropriate heat source apparatus.
5. Observe the development of latent prints. When maximum contrast has been achieved between the latent print and the background, remove the remaining iodine crystals from the cabinet.
6. Remove the specimens from the cabinet.
7. Photograph the developed fingerprint as soon as possible or, alternatively, fix the developed print with fixing chemicals.

Fume Circulation Procedure:

In addition to the equipment required for the regular cyanoacrylate fuming procedure, the fume circulation technique requires a small battery-operated fan or air-circulating pump.

1. Place the specimens and Super Glue in the porcelain dish into the cabinet as in the regular procedure.
2. Turn on the fan. Its motion will circulate the fumes and increase the surface contact between latent print residues and cyanoacrylate vapors. Alternatively, a small circulating motor, such as a fish tank water pump, can be used to force the cyanoacrylate vapors to circulate in the fuming tank.

3. Allow the item to fume for 1 to 2 hr until a whitish-colored print appears. The developed prints may be enhanced by dusting.

2. Superglue Fuming:

History: Exposure to superglue vapour was reported as a possible method for the development of latent fingerprints in the late 1970s. It was reported apparently independently in Japan and North America.

Mechanism: Cyanoacrylate esters, such as ethyl ester, are colorless, monomeric liquids.

CA forms vapors which interacts with certain eccrine components of latent fingermark residues and gets polymerized and imparts a white color to them. This hard, white polymer is known as polycyanoacrylate. It undergoes polymerization in the presence of water (weak base). The polymerization proceeds by the initiation and chain growth of the cyanoacrylate monomer by chemical components that exist in the latent fingermark deposit.

The quality of the developed print is intimately linked to the ability of the chemicals that exist in the fingermark to successfully polymerize the cyanoacrylate monomer, grow structures off the print ridge, and develop the optical contrast needed to view the print.

It is also suggested that short chains, oligomers, of cyanoacrylate may be formed due to atmospheric humidity which may the take part in further polymerisation on the fingerprint or substrate. The reaction of cyanoacrylates with latent print residue is considerably more complicated and less well understood. There are undoubtedly other bases within fingerprint residues and some of these may also initiate polymerization. Most fingerprints, however, have an initially significant water and chloride content, this is therefore likely to be a significant initiation mechanism. Recent research suggest lactate and alanine (from eccrine) initiate the polymerization.

Procedure:
1. Place the articles bearing latent fingermarks into the cabinet. Their surfaces should be exposed to the cyanoacrylate fumes.
2. Place few drops of liquid cyanoacrylate into a small porcelain dish and place the dish into the fuming cabinet.
3. Allow the items to be exposed to the fumes until whitish-colored fingerprint patterns appear.

Super glue fuming chamber:
Pre-treatment and post treatment: With the passage of time, natural dehydration occurs in latent fingermark deposit. Development of these latent fingermarks is difficult due to their exposure to harsh environmental conditions such as low humidity, UV light, or heat.

Several pre-treatment methods intended to reintroduce moisture to dehydrated fingermarks have been reported. Such as using ammonia vapours. Pre-treatment with methylamine solution improves the polymerization of cyanoacrylate.

The cyanoacrylate-developed print may be further enhanced by dusting with regular or magnetic fingerprint powder. The cyanoacrylate developed fingerprints can further be enhanced by using Rhodamine 6G.
Ardrox, Basic Yellow 40

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Advances in Fingerprint technology, Edited by Henry C lee, Robert Ramotowski and R.E Gaensslen, CRC press 2001

Topics for Student's presentations: 40 marks

Distribution:

20 marks: Presentation

10 marks: Write-up

10 marks: Viva

Unit 2: Injuries

Mechanical injuries: Abrasions, Contusion, Laceration (what are they and their medicolegal aspects)	Roll no 1	25/03/2021
Mechanical injuries: Stab wound, Incised wound, Defence wound (what are they and their medicolegal aspects)	Roll no 2	25/03/2021
Heat: heat exhaustions, heat syncope, heat fatigue, heat stroke and heat cramp and Symptoms	Roll no 3	25/03/2021
Heat: Postmortem appearance	Roll no 4	24/03/2021
Cold : Definitions, Symptoms	Roll no 5	24/03/2021
Cold : Postmortem appearance	Roll no 6	24/03/2021
Lightening: Definitions, Mechanism	Roll no 7	23/03/2021
Lightening : Postmortem appearance	Roll no 8	23/03/2021
Electrocution Definitions, Symptoms	Roll no 9	23/03/2021
Electrocution: Postmortem appearance	Roll no 10	23/03/2021

Unit 3: Asphyxia

Hanging: Definitions, Classifications, cause of death	Roll no 11	22/03/2021
Hanging: Postmortem appearances	Roll no 12	22/03/2021
Strangulation: Definitions, classifications, cause of death	Roll no 13	22/03/2021
Strangulation: Postmortem appearances	Roll no 14	22/03/2021
Suffocation: Definitions, classifications, cause of death	Roll no 15	20/03/2021
Suffocation: Postmortem appearances	Roll no 16	20/03/2021

Unit 4: Sexual Offences

Rape: Medical examination of Victims, collection and preservation of trace evidences	Roll no 17	20/03/2021
Rape: Medical examination of Accused, collection and preservation of trace evidences	Roll no 18	19/03/2021
Unnatural Sexual offences: Incest, lesbianism and Bestiality: examination of accused and victim, collection and preservation of trace evidences	Roll no 19	19/03/2021
Unnatural Sexual offences : Sodomy: examination of accused and victim, collection and preservation of trace evidences	Roll no 20	19/03/2021

NAME :- ALEFIYA .S. ATTARWALA

2019 - 20

CLASS:- MSC PART - 2

PAPER :- 03

SUBJECT :-Materials and Analytical Tools.

TOPIC :-XRF AND ED-XRF

A.Y. 2019-20

NAME	:	**SHRUTI PAWAR**
SEMESTER	:	**III**
COURSE	:	**M.Sc FORENSIC SCIENCE (Questioned Documents, Fingerprints and Forensic Physics)**
PAPER CODE	:	**PSFSQ 303**
SUBJECT	:	**Materials and Analytical tools**
TOPIC FOR PRESENATATION	:	**ICP-MS and LA-ICP-MS**

NAME	:	SHRUTI PAWAR
SEMESTER	:	III
COURSE	:	M.Sc FORENSIC SCIENCE (Questioned Documents, Fingerprints and Forensic Physics)
PAPER CODE	:	PSFSQ 302
SUBJECT	:	Advanced Fingerprint Technology – I
TOPIC FOR PRESENATATION	:	Fingerprints development /treatment on challenging surfaces

NAME :- ALEFIYA .S. ATTARWALA

CLASS:- MSC - 2

PAPER :- 03

UNIT :- 3 & 4

TOPIC :-DESSICATED REMAINS & ILLUMINATING LIGHT SOURCE

Forensic Science
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NAME	:	**DIVYA MHATRE**
SEMESTER	:	**III**
COURSE	:	**M.Sc FORENSIC SCIENCE (Questioned Documents, Fingerprints and Forensic Physics)**
PAPER CODE	:	**PSFSQ 302**
SUBJECT	:	**ADAVANCED FINGERPRINT TECHNOLOGY-I**
TOPIC FOR PRESENATATION	:	**DEVELOPMENT ON CHALLENGING SURFACES(ADHESIVE SIDE, WET SURFACES AND HUMAN SKIN)**

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2019-2020

NAME: Deepa Raju

SEMESTER: III

COURSE: MSc. Forensic Science - II

PAPER CODE: PSFS Q301

SUBJECT: Advanced Document Examination - I

TOPIC FOR PRESENTATION: SIGNATURE

NAME :- ALEFIYA .S. ATTARWALA

CLASS:- MSC - 2

PAPER :- 02

SUBJECT :- QUESTIONED DOCUMENTS

TOPIC :-ANONYMOUS LETTERS

NAME	**:**	**DIVYA MHATRE**
SEMESTER	**:**	**III**
COURSE	**:**	**M.Sc FORENSIC SCIENCE (Questioned Documents, Fingerprints and Forensic Physics)**
PAPER CODE	**:**	**PSFSQ 301**
SUBJECT	**:**	**ADVANCED DOCUMENT EXAMINATION- I**
TOPIC FOR PRESENATATION	**:**	**TYPEWRITERS**

NAME	:	SHRUTI PAWAR
SEMESTER	:	III
COURSE	:	M.Sc FORENSIC SCIENCE (Questioned Documents, Fingerprints and Forensic Physics)
PAPER CODE	:	PSFSQ 301
SUBJECT	:	ADVANCED DOCUMENT EXAMINATION- I
TOPIC FOR PRESENATATION	:	PHOTOCOPIER AND PHOTOCOPIED DOCUMENTS

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (II) Forensic Science

2018-19

NAME: SHACHI PATHAK

ROLL NO: 04

SEMESTER: IV

SUBJECT: Forensic Physics

TOPIC: Analysis of Gems and Crystals

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (II) Forensic Science

2018-19

NAME: Ketan Dilip Kambli

ROLL NO: 03

SEMESTER: IV

SUBJECT: Forensic Physics

TOPIC: Glass as Forensic Evidence (Case Studies)

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (II) Forensic Science

2018-19

NAME: MANOJ BHAGWAN SHIRSAT

ROLL NO: 06

SEMESTER: III

SUBJECT: Forensic Physics

TOPIC: Matching of Glass

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (II) Forensic Science

2018-19

NAME: KETAN DILIP KAMBLI

ROLL NO:

SEMESTER: III

SUBJECT: FORENSIC PHYSICS

TOPIC: BASICS OF ATOMIC SPECTRA

INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2018-2019

NAME: Arundhati Kirtikumar Pradhan

SEMESTER: IV

COURSE: M.Sc. Forensic Science

PAPER CODE: P5

SUBJECT: Forensic Physics

TOPIC FOR PRESENTATION: Soil

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2018-2019

NAME: Ashwini durgawli

ROLL NO: 02

SEMESTER: IV

PAPER CODE: P5

SUBJECT: Forensic Physics

TOPIC FOR PRESENTATION: Glass: Types of Glass

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2018-2019

NAME: DINESH BODADE

ROLL NO: 1

SEMESTER: IV

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P5

SUBJECT:FORENSIC PHYSICS

PRESENTATION TOPIC: Refractive index measurement & Glass Fracture Identification

Name - Ashwini R. Durgawale
Roll No - 04

TOOLMARKS

A.Y.: 2018-19
SEM - III

❖ Introduction

- A toolmark is defined as the impression left by the contact of a tool (or a similar object) onto a surface.
- When the tool or object contacts the surface with sufficient force to create an indentation, the pattern of the tool is permanently reproduced onto that surface.
- Toolmarks examination is an important discipline of criminalistics.
- Its goal is to establish a link between a toolmark and the tool that created it.
- Such links are crucial in forensic sciences, as tools are often used in criminal activities, particularly in burglaries, and can help to identify a criminal.
- If the tool is found with, or near, a suspect, it permits the establishment of a link between the suspect and the crime scene. Thus, the recognition and collection of toolmarks at the crime scene and their examination at the laboratory are paramount.

❖ Class And Individual Characteristic of Tool Marks

Tool marks bear two kinds of characteristics: class and individual.

- **Class characteristics**
- The class characteristics of a toolmark include the type of impression, its general shape, and its general dimensions.
- Class characteristics typically allow the examiner to determine what type of tool created the impression and how the mark was created.
- Conversely, they do not permit for the identification of the exact tool that created the impression.
- This means that if only class characteristics are available on a toolmark, it will not be possible to distinguish which tool, among a series of similar tools, made the impression.

- **Individual characteristics**
- Individual characteristics, also called accidental characteristics, are the striations and small particularities exhibited by the tool that are individual to one unique tool.
- They consist of small, commonly microscopic, indentations, ridges, and irregularities present on the tool itself.
- For example, the tip of a screwdriver is never perfectly flat, but shows small ridges along its edge.
- These are created by the history of the tool such as its use and misuse, its cleaning, and its maintenance.

These characteristics are the only ones that permit a formal identification. If such characteristics are present in the toolmark, it is possible to identify the actual individual tool that created the impression, even among a series of identical tools.

❖ Types of Tool Marks

There are two main types of toolmarks that can be distinguished: slipped and molded impressions.

- **The slipped impression**
  - It occurs as the tool drags or slides across the surface.
  - The resulting toolmark is a series of striations running parallel to each other following the direction of the drag.
  - For example, such impressions are created by slipping a key across the door of a vehicle, by cutting with a knife (not used in a sawing motion) through a given material, or by cutting an electrical wire using a pair of lineman's pliers.
- **The molded impressions**

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2018-2019

FORENSIC PHOTOGRAMMETRY

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ROLL NO: 12

SEMESTER: IV

COURSE: M.Sc. Forensic Science

PAPER CODE: P1

SUBJECT: Emerging Trends in Forensic Science

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (II) Forensic Science

2018-19

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SEMESTER: IV

SUBJECT: Emerging Trends in Forensic Science

TOPIC: Failure of Storage Vessels

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

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SEMESTER: IV

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SUBJECT: Emerging trends of forensic science

TOPIC FOR PRESENTATION: Age progression

INSTITUTE OF FORENSIC SCIENCE, MUMBAI
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PAPER CODE: P1

SUBJECT: Forensic science

TOPIC FOR PRESENTATION: Component Failure in Road Accident

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

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COURSE: M.Sc. Forensic Science

PAPER CODE: P1

SUBJECT: Emerging Trends in Forensic Science

TOPIC FOR PRESENTATION: Analysis of gems and coloured stones

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2018-2019

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SEMESTER: IV

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P1

SUBJECT: EMERGING TRENDS IN FORENSIC SCIENCE

PRESENTATION TOPIC: FRAUD INSURANCE CLAIM

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (II) FORENSIC SCIENCE

2018-19

NAME: SHIVANI SATISH SURVE

ROLL NO.: 14

SEMESTER: IV

PAPER: PSFS401

SUBJECT: EMERGING TRENDS IN FORENSIC SCIENCE

TOPIC: ANALYSIS OF POLLEN AND DIATOMS

INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2018-2019

NAME: Arundhati Kirtikumar Pradhan

SEMESTER: IV

COURSE: M.Sc. Forensic Science

PAPER CODE: P1

SUBJECT: Emerging trends in Forensic Science

TOPIC FOR PRESENTATION: Mineralogical analysis of Soil

INSTITUTE OF FORENSIC SCIENCE, MUMBAI.

2018-2019

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Roll No.: 10

Semester: IV

Course: MSc. FORENSIC SCIENCE

Subject: EMERGING TRENDS IN FORENSIC SCIENCE

Paper Code: P1

Topic of Presentation: FORENSIC WATER ANALYSIS

INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2017-2018

NAME: Arundhati Kiritkumar Pradhan
ROLL NO: 16
SEMESTER: I
COURSE: M.Sc. Forensic Science
PAPER CODE: P3
SUBJECT: Forensic physics
TOPIC FOR PRESENTATION: safety aspects of handling firearm and ammunition

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: VAISHALI JEETENDRA GAGWANI

ROLL NO: 05

SEMESTER: II

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P3

SUBJECT: FORENSIC PHYSICS

TOPIC FOR PRESENTATION: TREATMENT OF 2D FOOTWEAR IMPRESSIONS.

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

(2017-2018)

NAME: VAISHALI JEETENDRA GAGWANI

ROLL NO: 05

SEMESTER: I

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P3

SUBJECT: FORENSIC PHYSICS

TOPIC FOR PRESENTATION:

'PROPELLANTS AND THEIR COMPOSITIONS'

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-18

NAME: ASHWINI RAMAKANT DURGAWLI.

ROLL NO: 04

SEMESTER: I

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P3

SUBJECT: PHYSICS

TOPIC FOR PRESENTATION: RESTORATION OF SEARIAL NUMBER

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (I) Forensic Science

2017-2018

NAME: Dhiraj Vasant Dalvi

ROLL NO: 03 (Three)

SEMESTER: 1

SUBJECT: Forensic Ballistics & Forensic Physics

TOPIC: Collection and Evaluation of Tyre, Tyre Marks, Tyre Residues, and Tyre Burts

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (I) FORENSIC SCIENCE

2017-18

NAME: SHIVANI SATISH SURVE

ROLL NO: 20

SEMESTER: II

PAPER: III

SUBJECT: MOTOR VEHICLE CRIMES & FORENSIC PHYSICS

TOPIC: BITEMARKS

INSTITUTE OF FORENSIC SCIENCE,
MUMBAI
2017-2018

NAME: MANOJ B. SHIRSAT

ROLL NO: 19

SEMESTER: II

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P3

SUBJECT: FORENSIC PHYSICS

TOPIC FOR PRESENTATION: FOOTPRINT SIZING AND FORENSIC CONSIDERATION

INSTITUTE OF FORENSIC SCIENCE, MUMBAI.

2017-18

NAME: MANASI SHEWALE

ROLL NO: 18

SEMESTER: II

COURSE: M.Sc. Forensic Science

PAPER CODE: P3

SUBJECT: Forensic Physics

TOPIC OF PRESENTATION: EAR PRINTS.

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: NEEDA ASHRAF PETKAR

ROLL NO: 15

SEMESTER: II

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P3

SUBJECT: MOTOR VEHICLE CRIMES & FORENSIC PHYSICS

PRESENTATION TOPIC: CHEMICAL ENHANCEMENT OF FOOTWEAR IMPRESSIONS IN BLOOD

INSTITUTE OF FORENSIC SCIENCE, MUMBAI
2017-2018

NAME: Arundhati Kirtikumar Pradhan
ROLL NO: 16
SEMESTER: II
COURSE: M.Sc. Forensic Science
PAPER CODE: P3
SUBJECT: Forensic physics
TOPIC FOR PRESENTATION: Examination procedure for footwear impressions

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: SHACHI PATHAK

ROLL NO: 13

SEMESTER: II

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P3

SUBJECT: FORENSIC BALLISTICS AND FORENSIC PHYSICS

TOPIC FOR PRESENTATION:

GENERAL INFORMATION REGARDING FOOTWEAR IMPRESSIONS EVIDENCE AND THEIR IMPORTANCE

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: Lakshmi. S. Panicker

ROLL No: 12

SEMESTER: II

COURSE: M.Sc. Forensic Science

PAPER CODE: P3

SUBJECT: Motor Vehicle Crimes and Forensic Physics

TOPIC FOR PRESENTATION: Photography of footwear impressions.

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: ANKITA JITENDRA MARU

ROLL NO: 10

SEMESTER: 2

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P6

SUBJECT: FORENSIC BALLISTICS

PRESENTATION TOPIC: KNOWN SHOES OF SUSPECTS AND PREPARATION OF KNOWN IMPRESSIONS

INSTITUTE OF FORENSIC SCIENCE
• MUMBAI •

Name: Aishwarya Nair

Roll no.: 11

Class: M.Sc. Part I

Course: Forensic Science

Semester II

Topic : Casting Three Dimensional Footwear Impressions

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: SHREYA KHOCHARE

ROLL NO: 8

SEMESTER: II

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P4

SUBJECT: MOTOR VEHICLE CRIMES & FORENSIC PHYSICS

PRESENTATION TOPIC: FORMATION OF FOOTWEAR IMPRESSIONS

07

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (I) Forensic Science

2017-18

NAME: Ketan Dilip Kambli

ROLL NO: 07

SEMESTER:II

SUBJECT: Motor Vehicle Crimes & Forensic Physics

TOPIC: Restoration of Obliterated Marks

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (I) Forensic Science

2017-18

NAME: RIDDHI DILIP GHOSALKAR

ROLL NO: 06

SEMESTER: 2

SUBJECT: MOTOR VEHICLE CRIMES & FORENSIC PHYSICS

SUBJECT CODE: PSFS 203

TOPIC: LIP PRINTS

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: DINESH BODADE

ROLL NO: 1

SEMESTER: II

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: P4

SUBJECT: MOTOR VEHICLE CRIMES & FORENSIC PHYSICS

PRESENTATION TOPIC: CHEMICAL ENHANCEMENT METHODS FOR RESIDUE IMPRESSIONS

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: Anurag BhupeshPatil.

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SEMESTER: III

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: PSF305

SUBJECT: Forensic Physics

TOPIC FOR PRESENTATION:

"Lambert-Beer's Law & Calibration"

DATE OF SUBMISSION: 26/09/2017

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

P5

Forensic Physics

Rotational & Vibration Spectra And Molecular bonding

Sujyot.Shyam.Shirke

Roll No: 03

MSc – 2 Sem III

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: Supriya Khanderao Patil.

ROLL NO: 02

SEMESTER: III

COURSE: M.SC FORENSIC SCIENCE

PAPER CODE: PSF305

SUBJECT: Forensic Physics

TOPIC FOR PRESENTATION:

"Basics of Atomic Spectra"

DATE OF SUBMISSION: 21/09/2017

INSTITUTE OF FORENSIC SCIENCE
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INSTITUTE OF FORENSIC SCIENCE, MUMBAI

2017-2018

NAME: Sujyot Shirke

ROLL NO: 03

SEMESTER: IV

PAPER CODE: P5

SUBJECT: Forensic Physics

TOPIC FOR PRESENTATION: Glass

INSTITUTE OF FORENSIC SCIENCE, MUMBAI

M.Sc. (I) Forensic Science

2017-18

NAME: KETAN DILIP KAMBLI

ROLL NO: 07

SEMESTER: 1

SUBJECT: FORENSIC BALLISTICS & FORENSIC . PHYSICS

TOPIC: TYPES OF AMMUNITION