Forensic Applications of Comparison Microscope

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Introduction

A comparison microscope is a crucial instrument in forensic evidence examination; it contributes its applicability in several pieces of evidence of different nature. It stretches its most applications in forensic ballistics evidence examination. From the scene of the crime involving shooting incidences, majorly two types of exhibits are recovered – fired bullets and the empty cartridge shells. For investigative purposes, linkage of these pieces of evidence with the firearm involved was established. According to the principle of individuality given by Paul L. Kirk (1963) in forensic science, no two objects, whether natural or artificial, can be precisely the same, so the marks produced by them also remain unique. Kirk claimed that forensic science aims to focus on the source of two items (questioned and known, or pattern and print), which are believed to have come from a single source. The use of a comparison microscope is candid in forensic tool marks examination. Some examiners keep comparison microscopes in the preview of forensic ballistics. Still, it is not complete if we do not include other forensic branches like forensic physics, forensic biology or document examination.

A comparison microscope consists of two compound or stereomicroscopes connected by an optical bridge used to view two specimens side by side in a split view window. In forensic science, this microscope is used to compare the questioned sample with a reference sample at the same time. This microscope is constructed so that it can help to examine not only trace evidence but also bulk evidence. This microscope provides information on whether the sample originated from a particular source or not. This microscope helps to identify the class and individual characteristics of the physical evidence.

Without this device, identification of tool marks and firearms would have been a cumbersome and time-consuming process and very likely to make an error, as it would have directly impacted the image if any of the instruments had changed positions during the examination. This change in the image may cause difficulty in comparing the two samples.

Side-by-side comparison of two samples at the same time is the main advantage of this microscope. It became possible because the optical bridge which has been introduced in this microscope helps to make a common path for two samples, despite being placed at different stages. This optical bridge consists of a series of lenses and a mirror that brings the two images back together on a single eyepiece.

In the comparison microscope, different light settings such as reflected, ultraviolet, transmitted or fluorescent light are available, which are used to examine the other type of physical evidence.

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Evidence such as a fired bullet, fired cartridge cases and tool marks are observed using reflected light settings. In contrast, hair and fibre are observed under UV/fluorescent light setting apart from reflected light settings.

The Standard Operating Procedure

Procedure

- Turn on the switch.
- Turn on the light switches of the fibre optic lights.
- Adjust the intensity of the lights.
- Adjust the stage height on both sides.
- Place the specimens to be examined on the stage.
- Turning the focus knob can move the two stages up and down. The elevating knob enables them to move either upwards or downwards, respectively.
- The luminescence light spot can be adjusted by turning the luminescence lens and its holder can also be regulated to the desired position.
- Adjust the diopter.
- Choice and adjustment of magnification: the right and left objectives in use must have the same magnification.
- View the samples on the screen using the basic software compatible with the instrument or through the eyepiece.

Calibration

- The comparison microscope will be calibrated with a glass slide with 0.04" ruled to 0.001".
- The slide should have a NIST traceable certificate.
- This will be documented in the instrument's maintenance/calibration logbook.

Standardization

- The comparison microscope will be checked to ensure that it is functioning correctly.
- This check will be performed by placing two similar items on each stage (test to test) and observing the agreement between these items.
- This would be documented in the examiner's case notes.

Precautions

This instrument must be kept in a shady and cool place, dry and well-ventilated. It must be free from dust, acid or alkali vapour. When not in use, it should be covered with a dustcover. All the lenses must be kept clean. If there is dust on the surface, it can be flicked off by an air blower or a soft hairbrush; if some greasy dirt gathers on the surface, it can be swept off by lens tissue slightly moistened with xylene.

Forensic Applications of Comparison Microscope

Ballistics

In the firing process, the firearm action mechanism involves contact of several parts with both cartridge and bullet, which produces exchange marks of specific nature on the contact surface of them both. On cartridges, chamber housing imparts the chamber marks, the strike of firing pin on the base of the cartridge imparts firing pin mark on percussion cap, and the extractor imparts extractor marks on the rim of the cartridge. On fired bullet, the rifling (lands and grooves) in the barrel imparts unique patterns in the form of striations on the surface of the bullet/shell passing throughout the length of the barrel.

For comparison of suspected bullets and cartridge shells (casings) from the scene of the crime, a cartridge of the same make and model is test-fired from the recovered firearm in controlled conditions to obtain a set of test-fired bullets and a casing.

The concerned impression, typically a **bullet or casing** found at a crime scene, is placed under the left microscope and thus, appears in the left part of the circular view field. The **bullet or casing** fired from the firearm in test conditions is placed below the right microscope and, thus, appears in the right part of the view field of the comparison microscope. For bullet-firearm linkage, the striation marks formed due to rifling are compared, as seen in Figure 8.1.

The striations are depressions produced by lands with an explicit angle of twist. The number of striations is subject to the number of lands and grooves specific to the manufacturer. As illustrated in Figure 8.1, the continuity of the striation pattern in both bullets (suspect and test-fired) placed side by side in the left and right view field was observed. In this examination, the lighting conditions of both the left- and right-side microscope are kept at the same illumination. While linking striations, the forensic scientist moves the comparison object (test-fired bullet) until the striations match the ones present on the incriminated bullet. If the striations present on both do not present similarities, then the expert cannot link the two bullets with a common origin. Similarly, the examination of impressions on casing performed by placing the (test-fired bullet) cartridge compared to various impressions present on cartridge casings were both placed on the left and right side

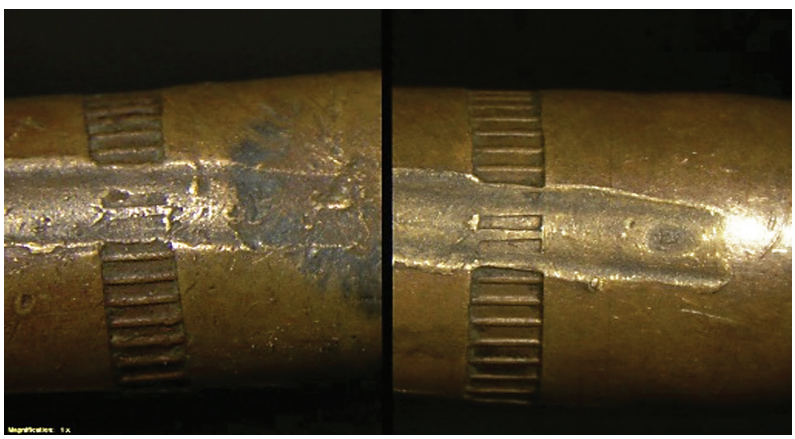

Figure 8.1 Side by side comparison of Rifling marks present on a test-fired and suspected bullet, continuity of striations can be observed.

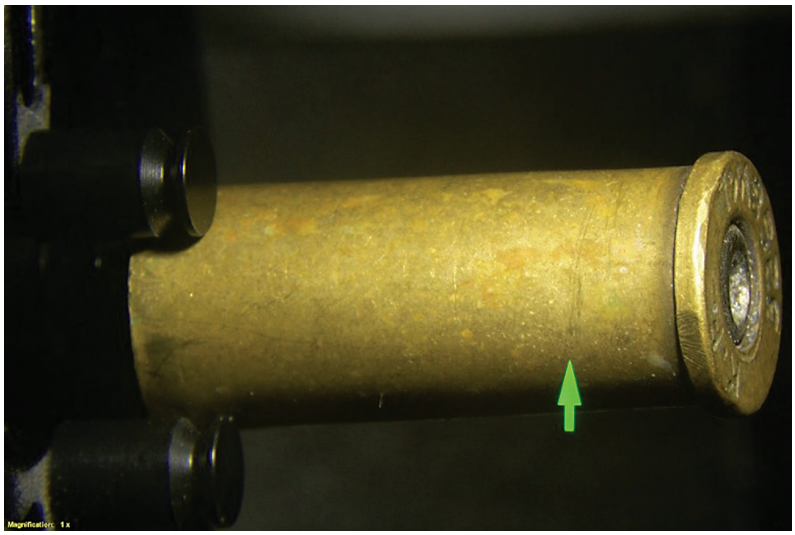

Figure 8.2 Cartridge shell with chamber marks.

Figure 8.3 Left and right view field demonstrating a comparison of firing pin marks.

of the microscope. The marks present on cartridge shells are firing pin marks, chamber marks, and extractor marks (Figures 8.2, 8.3, and 8.4).

Chamber marks are present on the lateral side of the cartridge produced due to chamber margins.

Impression Evidence

A comparison microscope is the best tool in forensic examination that is used to compare impression evidence side by side. Impressions of serial number or characters from

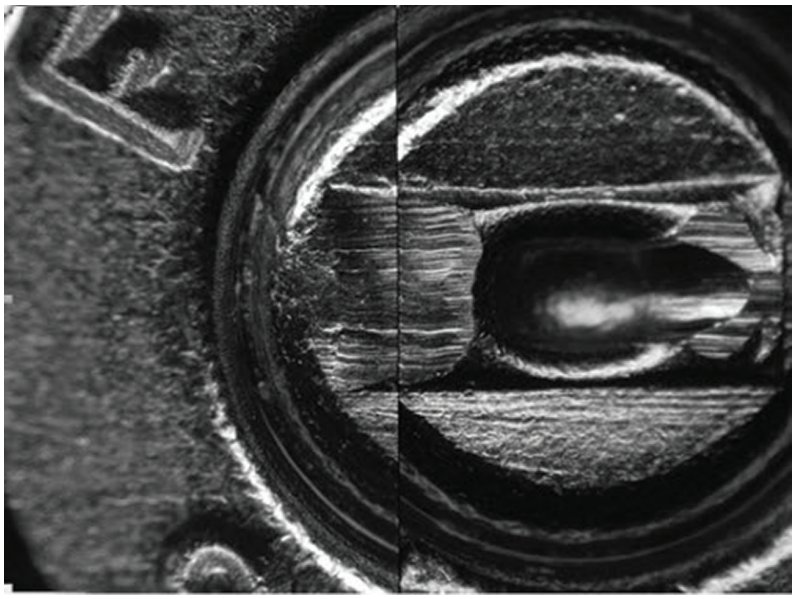

Figure 8.4 Two test-fired cartridge casing being compared with a comparison microscope. Matching striations between the two can be seen.

Adapted from FBI, 2009, Wikimedia Commons/Public domain/https://commons.wikimedia.org/wiki/File:Fired_cartridge_comparison.png

a typewriter can be compared under a reflected light setting. The result of its link can be easily established between the die and stamped serial number or between the feature of the typewriter that is used to write and a sheet of paper containing characters. This microscope is also implied to compare different layers of paint flakes/chips that help identify the source from where the paint originated.

In addition, hair, fibres and extruding striation marks on a plastic bag can also be examined through a comparison microscope with the setting of transmitted/UV/polarised light.

Tool Marks

If required, casting materials may be applied over the mark to be cast in the first step of tool marks identification. After that, when it is sufficiently set, gently tap the area to loosen the cast. In this way, a negative impression of the tool mark transferred to the cast can be put on the stage of comparison microscope to observe the fine class characteristics of the tool and find out irregularities or longitudinal striations, if any present on it.

Other Evidence

Besides the application in the field of ballistics and impression evidence, a comparison microscope is also used to examine banknotes, passports, scratch marks caused by axe, knives, saws, etc. Also, a comparison microscope is used to identify the source of hair and fibre like evidence based on their class and individual characteristics.

DOs and DON'Ts

DOs

- Quiet, Vibration- and dust-free space is essentially required to place the microscope.
- When the microscope is not in use, it should be covered.
- The eyepiece of the microscope should be offered at easily adjustable height ranges, and optical angle should be set before the work with the comfortable position of the elbow, wrist placement.
- The working distance of both sides of the microscope should be examined and set at equal height before the work begin.
- Stage of Microscope should be locked to avoid any unsynchronized movement.
- Lens cleaning fluids such as Ethyl ether or xylene are used to clean the optical surfaces of the lens.

DON'Ts

- The intensity of the light source should not be increased above the maximum permissible limit.
- Do not use a dirty or rough cloth to clean the lens, as it may scratch the surface of the lens.
- Microscopes are not kept in closed space or covered in a humid climate. This may increase the likelihood of fungal growth. In other words, the microscope should be kept open in a ventilated space under a working fan.
- Alcohol, acetone, or any other ketone are not used for lens cleaning purposes as these chemicals can damage the coatings of the lens and soften the sealers and cement around the lens.

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