Leica
MICROSYSTEMS

Forensic Science

Applications, Instruments, Solutions

What is Forensic Science ?

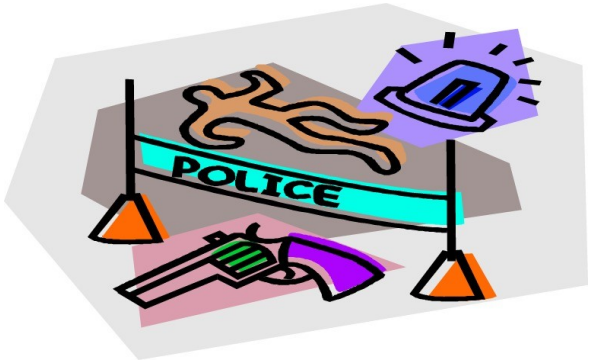
Sciences to answer questions of interest to the legal System

Firearms & Tool marks

Psychiatry & Profiling

Documents

Crime Scene Processing



Hairs / Fibres Glass / Paint

Forensic Medicine

Crime Scene Photography

Personal Identification

Macro - Micro

- **Macroscopic** is commonly used to describe physical objects that are measurable and observable by the naked eye.

- The term **microscopic** (Greek) means minute or very small, not visible with the eye unless aided by a microscope.

Fields of Applications

Firearms

Tool marks

Documents

Locks

Macro

Micro

Footprints

Paints

Particles

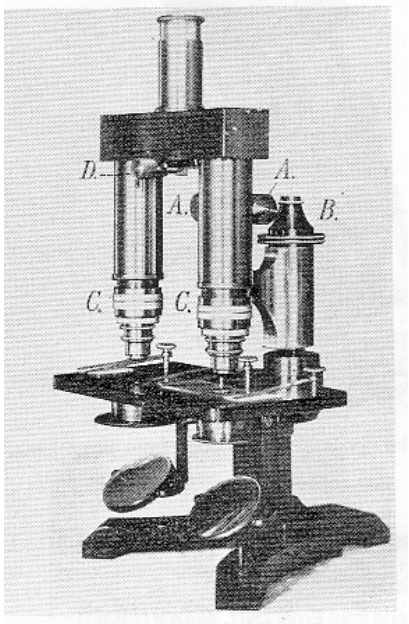
Glass

Hairs

Fibres

A view on history

1911 First comparison microscope (monocular)
W.&H. Seibert, Wetzlar

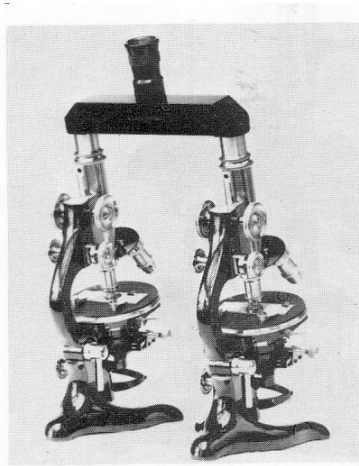


1922 New comparison microscope (monocular)
Ernst Leitz, Wetzlar

1931 First comparison microscope for forensic (binocular)
Ernst Leitz, Wetzlar

1967 New optical concept: split- and superimposed image
Ernst Leitz, Wetzlar

2003/05 Motorized Comparison Microscope LEICA FS 4000 / FS CB
Leica Microsystems Wetzlar GmbH

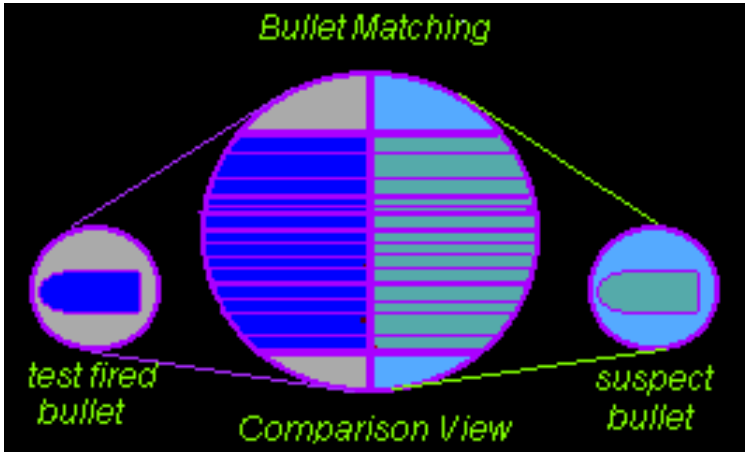


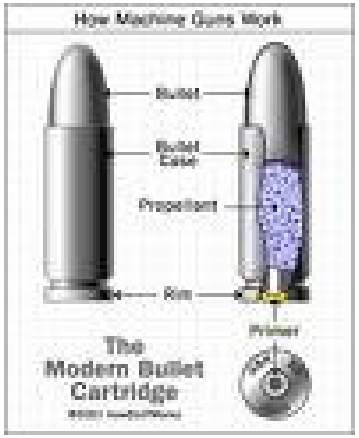
2008 Second Generation FSC / FS4000 / FS CB
Leica Microsystems Wetzlar GmbH

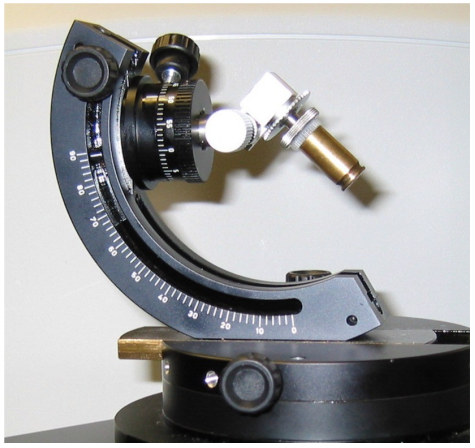
Ballistics / Firearms

(fired ammunition parts)

Firearms examination involves the identifying characteristics between firearm and projectile, projectile and target. Typically, this includes matching bullets to the gun that fired them

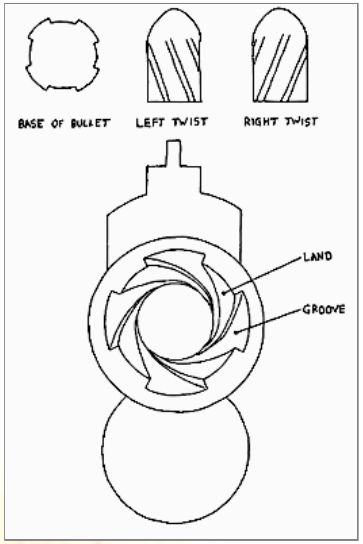






Ballistics / Firearms

(fired ammunition parts, primary marks)

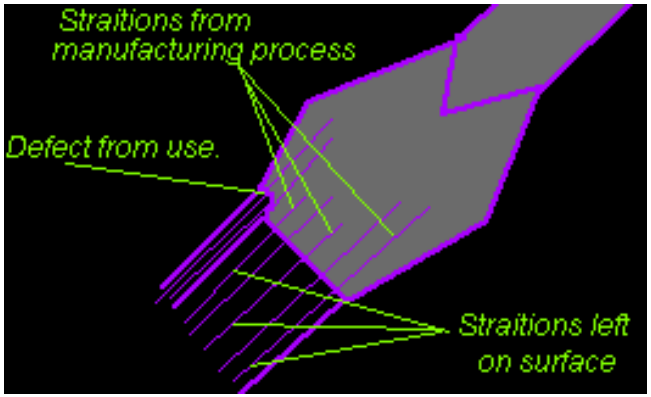


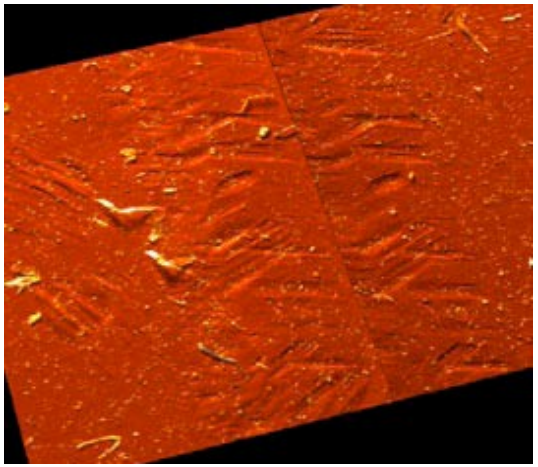
- Bullets
  - land impressions
- Cartridge cases
  - imprints of firing pin
  - marking of breech face
  - ejector / extractor marks

Tool Marks

(mechanical traces caused by tools)

Tool mark identification involves the identifying characteristics between tools, such as a pry bar, and the object on which it is used, such as a door frame. Also included in the category are explosives and imprint evidence.

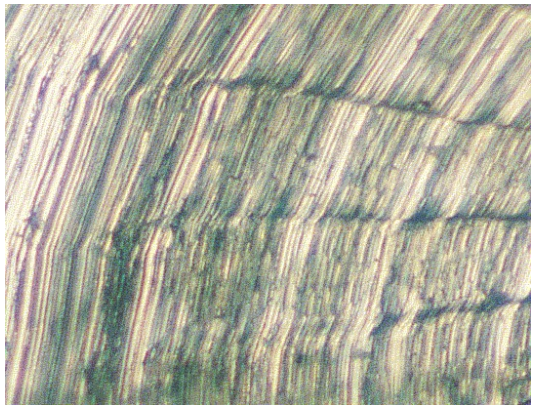


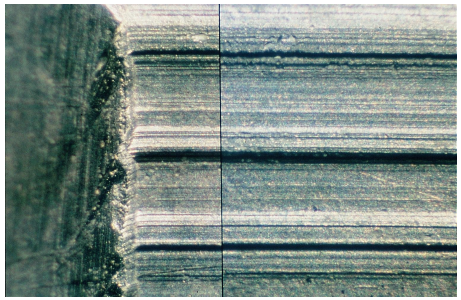


Tool Marks

(mechanical traces caused by tools)

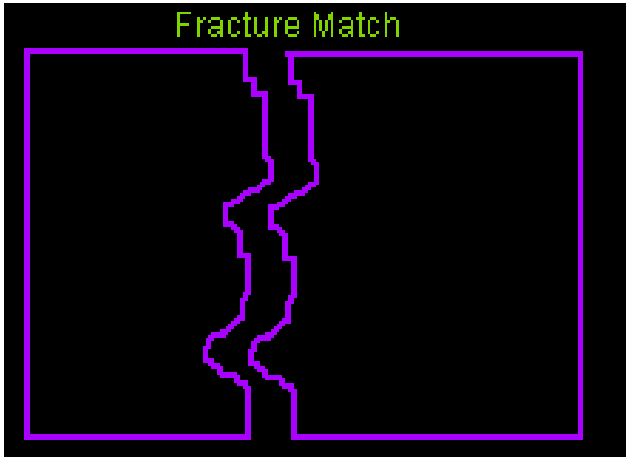
- Traces at the end of wires
- Traces of steel drills
- Characteristics of edges (knives)
- Traces of chisels & screwdrivers
- Lock cylinders & code pins

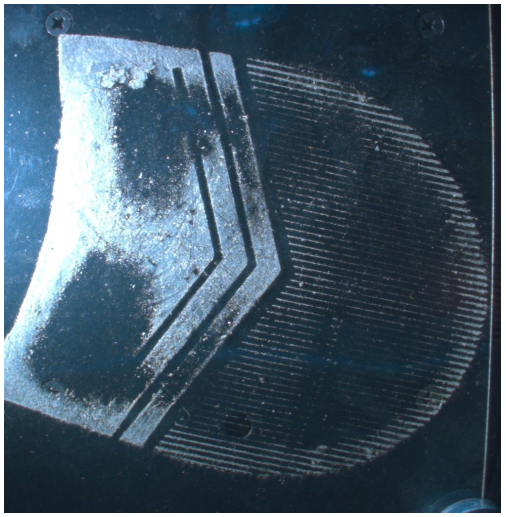




Questioned Documents

This discipline involves all special relationships that may exist between document and inscription and how it relates to a person or sequence of events. This includes forgery, counterfeiting, handwriting analysis and other related sub disciplines.

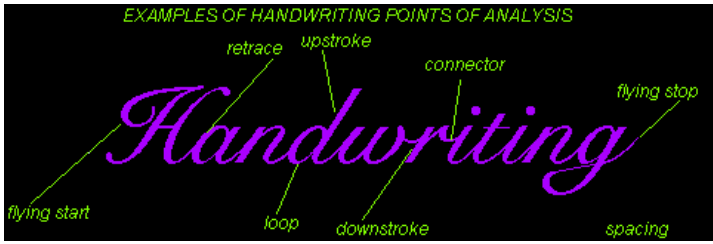


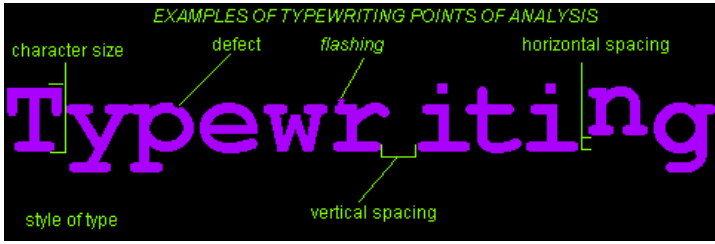


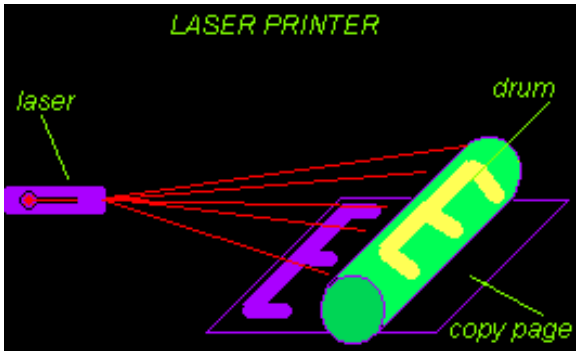
Applications for Macroscopes

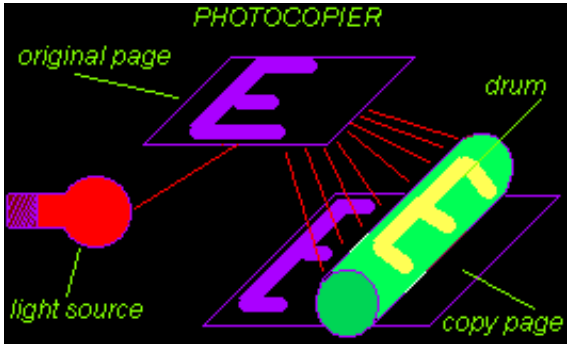
Questioned Documents include the ID of:

- Typewriting
- Handwriting
- Laser- & inkjet printing
- Forgery of banknotes
- Forgery of stamps & checks



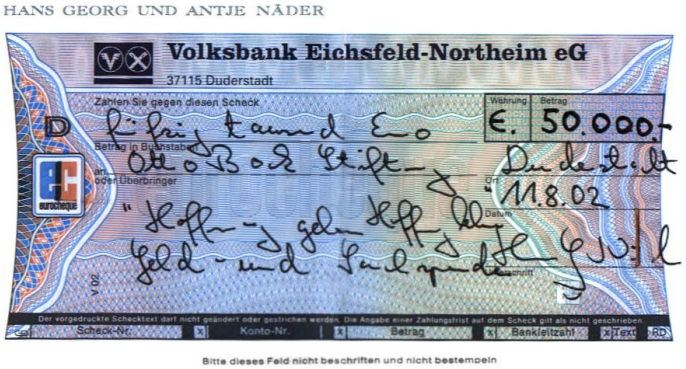






Questioned Documents

Documents of various types have enormous importance in our personal, social and business related every day life. The material or imaginary value of documents like passports, identity cards, driving licenses, credentials, authorizations, indentures, invoices, securities etc. is reason enough to steel, forge or copy them.



Safety features of interest include: water marks, mixed fibers, safety threads, specially designed printings with outstanding print technologies and –colors, micro scripture, copy protections, latent pictures, retro reflective symbols, holograms, dyeing of the iris, Laser-engravings etc.

Designer Drugs

Widely spread in the techno scene are narcotics like Ecstasy-pills. Originally the name Ecstasy was only used for the amphetamine derivate MDMA. In the meantime also MDE, MDA as well as other designer drugs are called Ecstasy (XTC). Pills with identical logos have often different active ingredients. Apparently ingredients depend on availability.

The examination of narcotics and ecstasy pills in the forensic laboratory is typically conducted through Mass spectrometers, IR-Spectrographs, chemical analysis but also by the use of light microscopy. With magnification of 100x it reveals details of the individual embossing tool left over from the manufacturing process.

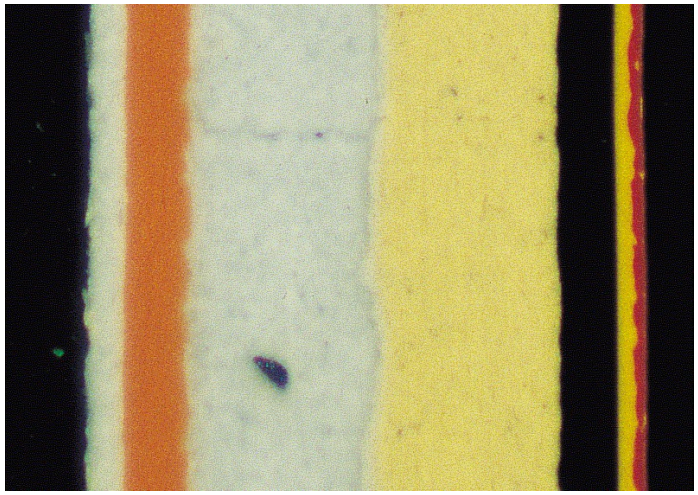
Trace Evidence Microscopy

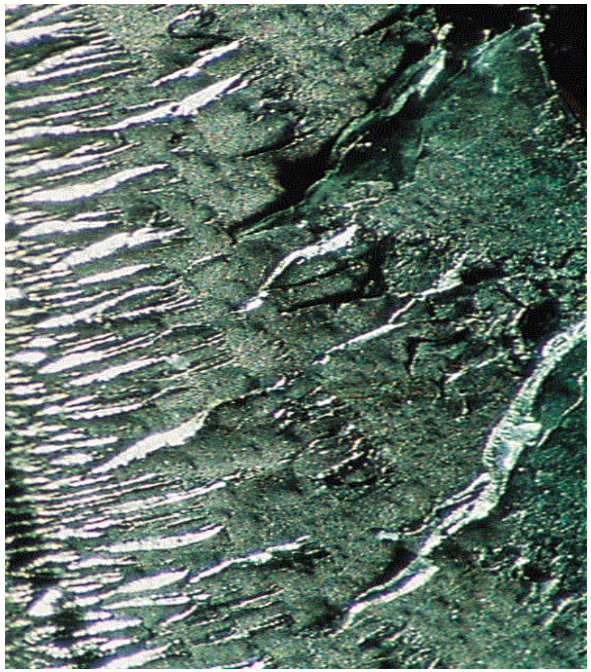
Living up to Life

- Hair
- Fibers
- Glass
- Paint
- Particles

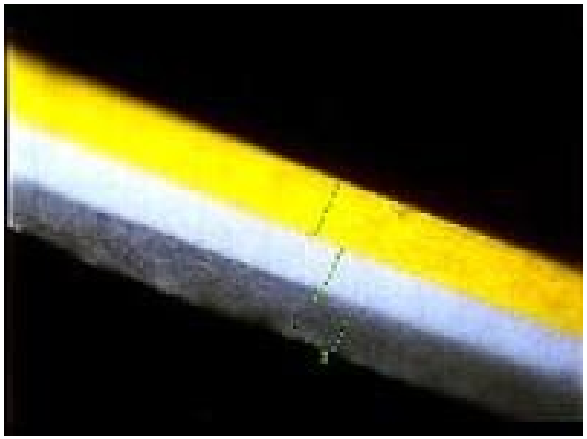
Glass & Paints

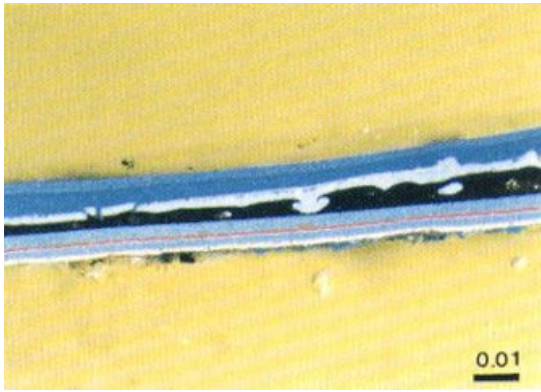
- breaking point of acrylic glass
- paint layers (car accidents)





Glass & Paints





Offenses where paints & lacquers are found:

- Traffic accidents with hit-and-run driving.
- Burglary, housebreaking
- Damage to property

Glass

Fragments of glass can be compared to determine if they originated from the same source.

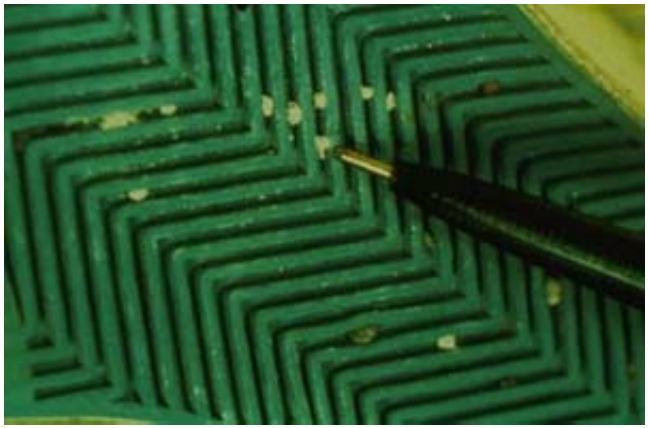
Properties that must be similar:

- tint, colour nuances
- thickness
- UV fluorescence
- density
- refractive index

Glass

Suspects breaking in through glass will usually get fragments of glass on their clothing and on the tool used to break. The particles (questioned glass) found by examining the clothing & tools can be compared to particles collected from the crime scene (known glass) to determine if they have a common origin.

Sole of a shoe

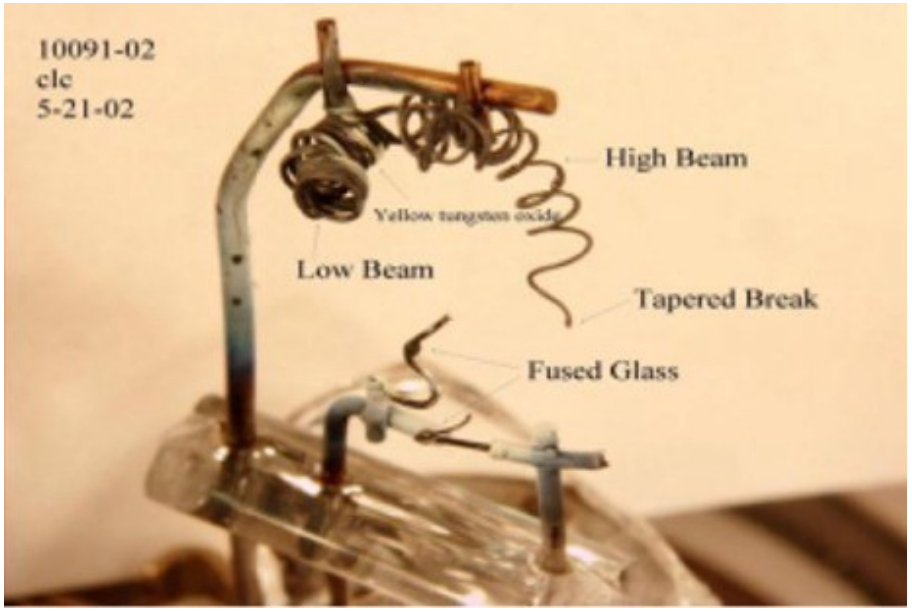


Glass

When a pedestrian is struck by a vehicle, the body may be lifted into the air and onto the windshield of the vehicle. Fragments of glass are often embedded in the victim's hair and clothing.

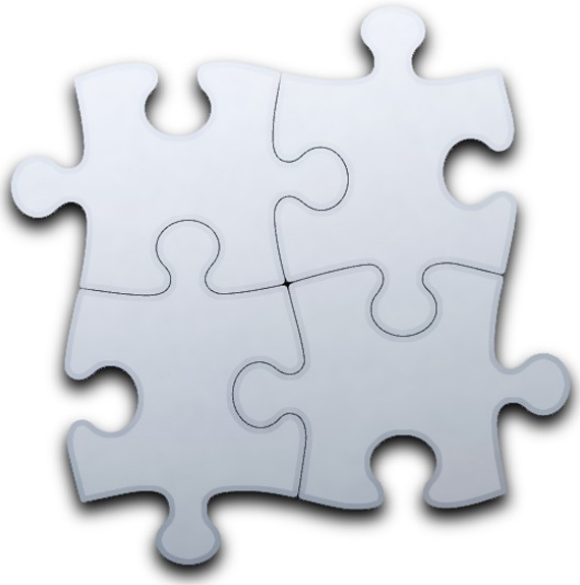
Glass (Headlamp Filaments)

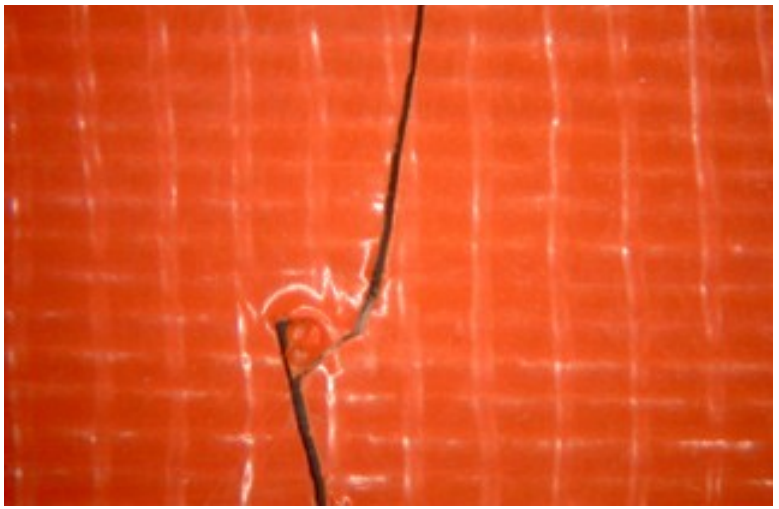
The filaments in the light bulbs are examined for oxidation, hot stretch, cold breaks, rainbowing, and fused glass particles. The analyst can then make the determination whether the headlamp(s) was on or off when the collision occurred.



Particles (Micro & Macro)

When an object breaks, tape is torn, or something is cut, two unique edges can be formed. These edges can be compared by the naked eye, and under high magnification to see if they fit together like puzzle pieces. If the edges fit together like a lock and key, they are said to physically match one another.





Particles (art forgery / restoration)

Ultraviolet fluorescence and infrared analysis are used to detect repairs or earlier painting on canvasses.

This portrait of Maria Isabella de Bourbon (1741-1763) is thought to be painted by Goya. Although the canvas was old and the paint bore the crackle marks of age, several scholars came to doubt the painting's authenticity.

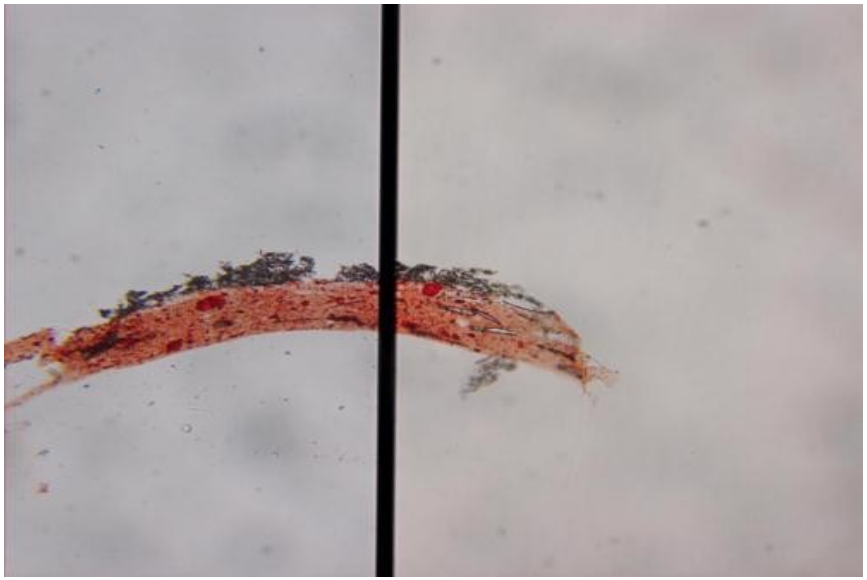
Upon completing the analysis, the conservators left the work as you see it (with portions of the original painting visible on the left and the newer forgery on the right) to illustrate the intricacies of art forgery and the inherent difficulty of detecting it.

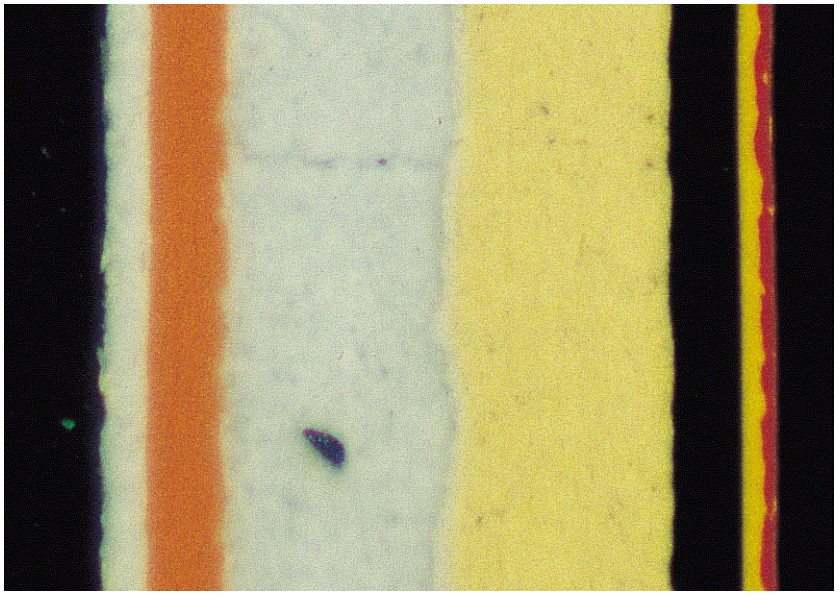
Paints

Paint can be transferred from one vehicle to another in an accident. An automotive paint chip left at the crime scene can be used to determine the make and model of the vehicle it came from.

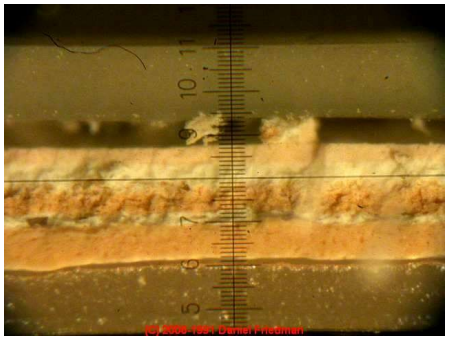
Paints

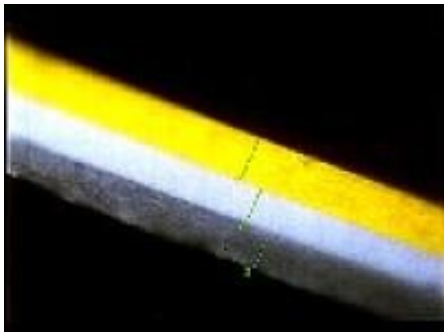
Paint is examined with microscopy and several analytic instruments to determine its layer sequence, binder type, and pigment content. If the Q and K paints are found to be similar in all these analyses, then they could have originated from the same source.

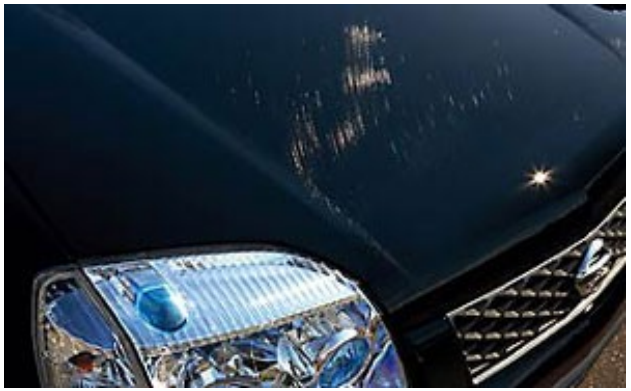




Paints





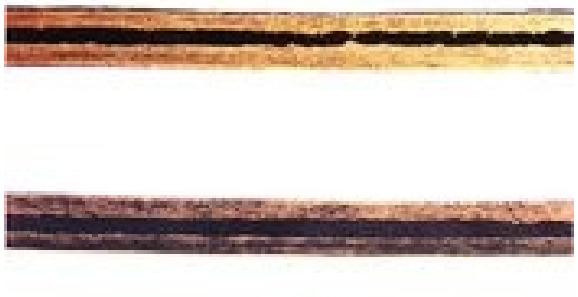


The primary focus lies on hit-and-run-driving. The predominant examination method is microscopic comparison. Paint particles found at the place of the accident are compared with the paint of suspicious cars. Varnishing of cars consists of three to four layers of paint that are characterized through their compound structure. The surface coat, the filler coat and the primer coat. Forensic examinations concentrate on the:

- Color of the individual layer particularly in regard to color nuances of the surface coat
- Thickness of the layers
- Micro morphology of the individual layer
- Flakes in effect paintings

Hairs & Fibers

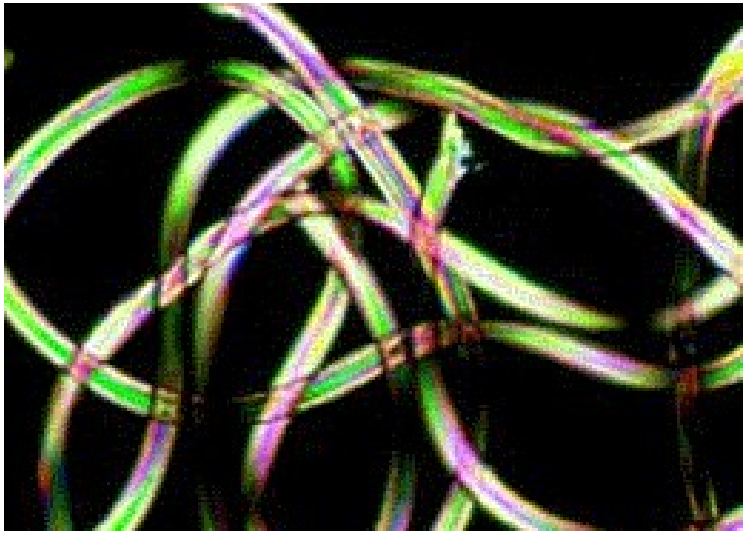
When a struggle occurs between two people, hairs and fibres may be transferred from the suspect or suspect's clothes to the victims' and vice versa.

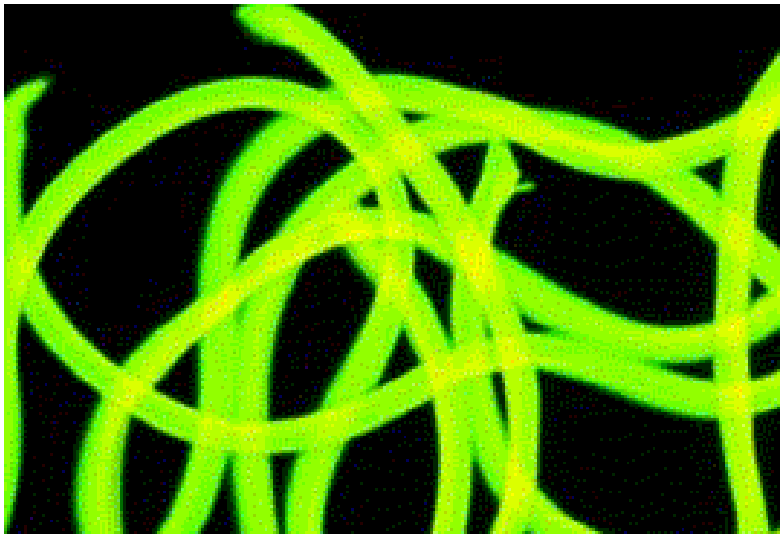


Human head hair with continuous medulla

Fibers

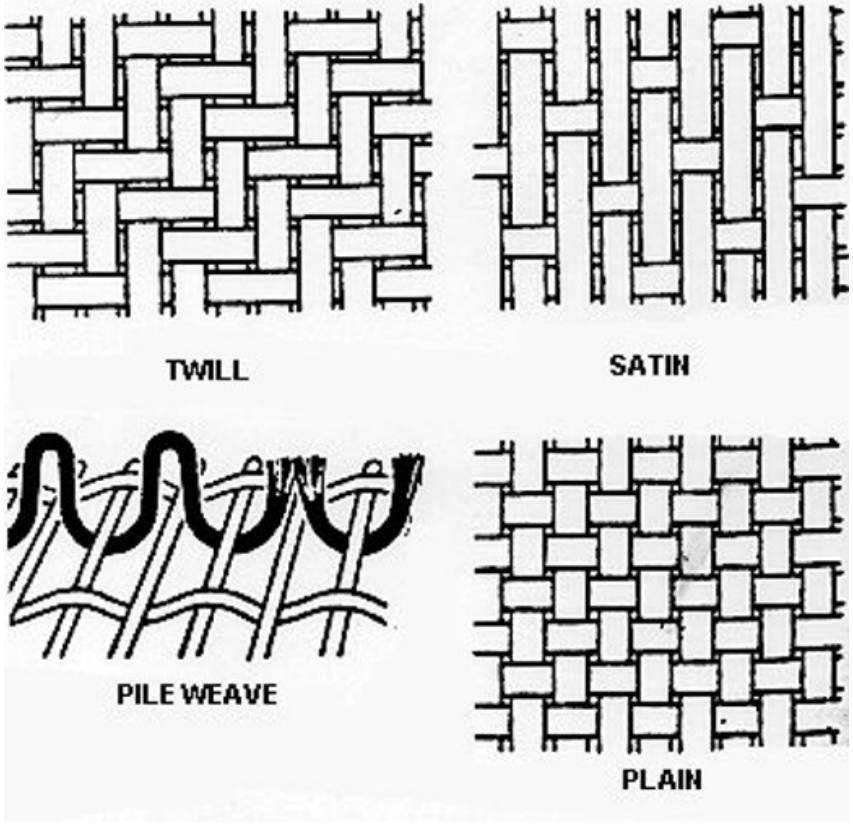
Carpet fibres from a home may adhere to a breaking and entering (B&E) suspect's shoes. A pedestrian struck by a vehicle may leave hairs and fibres from their clothing on the suspect's vehicle bumper or windshield.





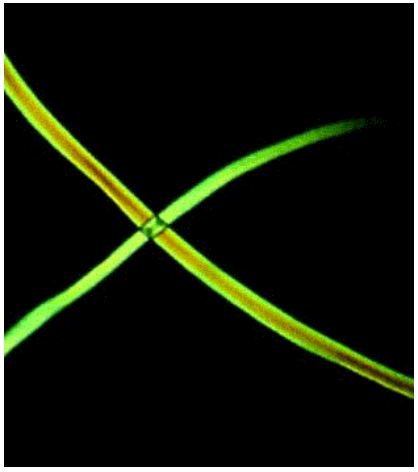
Fibers

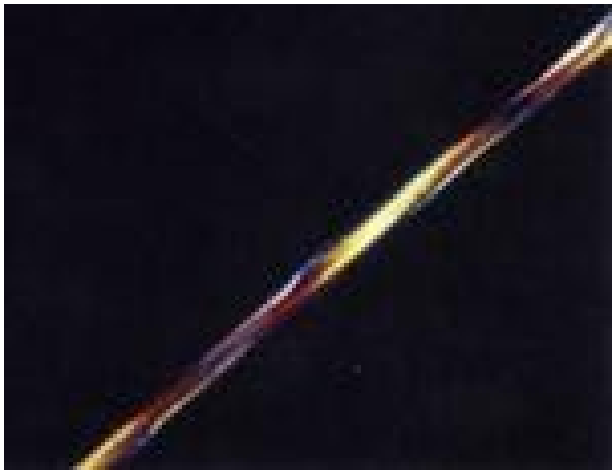
If a sample of fabric is available, a forensic scientist might look at the construction of the fabric to help trace it back to a particular type of clothing or particular weave patterns in the fabric might help in the search for evidence.



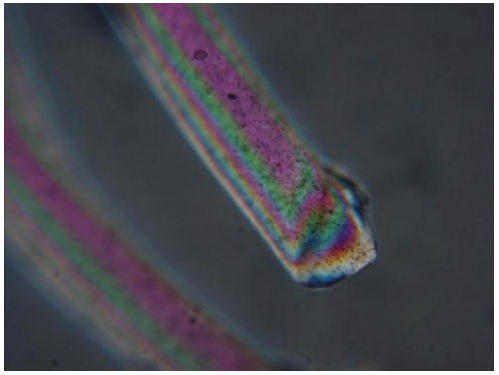
Fibers

A questioned (Q) and a known (K) fibre can be compared using PLM. The fibre type (i.e. Nylon, rayon, cotton, polyester, etc.), cross sectional shape, sign of elongation, and refractive index can be determined with PLM. Analytical instrumentation like FT-IR and Micro-spectrophotometry can be used to further identify and compare the Q and K fibre's chemical composition and colour to determine if the two fibres could have originated from the same source.

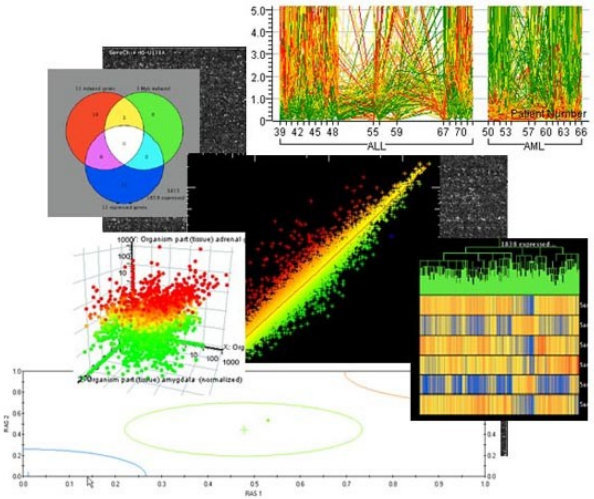




Hairs & Fibers are analyzed with:

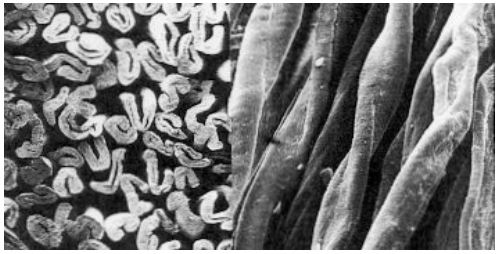


Stereoscopic Microscopy
Polarized Light Microscopy (PLM)
Ultraviolet Light Microscopy
Scanning Electron Microscopy (SEM/EDX)
Fourier Transform Infrared Spectroscopy (FT-IR)
Gas Chromatography / Mass Spectrometry (GCMS)
Pyrolysis Gas Chromatography (PGC)
Ion Chromatography (IC)
Micro-Spectrophotometry

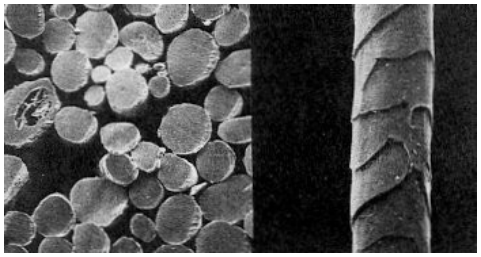


Fibres

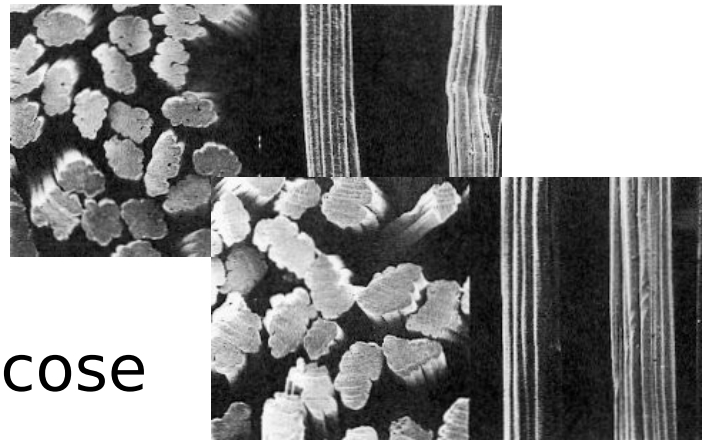
When the examined fibers look identical in brightfield contrast, the next step requires a fluorescence microscope. In FL-contrast, pigments shine in different colors that look identical in white light. However even the analysis of an expert using a microscope is subjective. Therefore, to get the final proof a spectral analysis is applied. It is measured how much light of a specific wavelengths is absorbed by the fiber.



Cotton



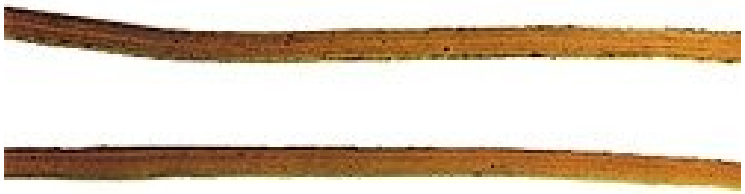
Wool



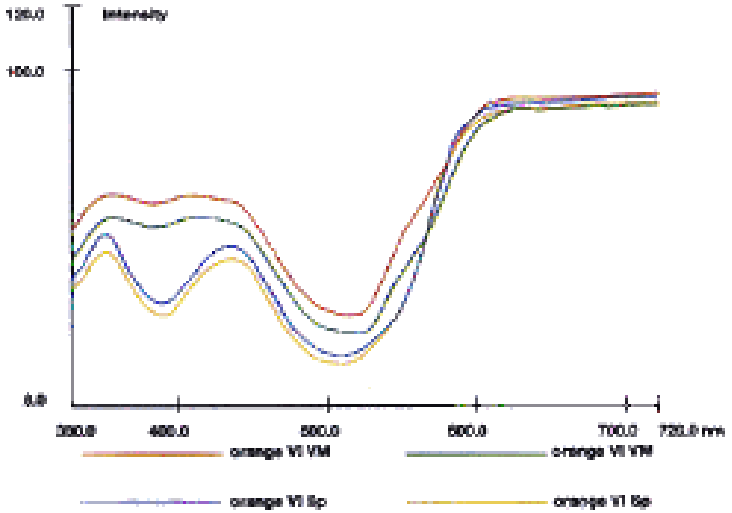
Viscose

Fibres

Not long ago, most fabrics were made of wool, cotton, linen or silk. Today a wide variety of synthetic fibres has appeared on the market, whose identification is much more difficult and requires special instrumentation.



Two apparently identical viscose fibers (Q & K) in brightfield



Spectra of the same viscose fibers that show the different color (dyeing)

Clues from Hair

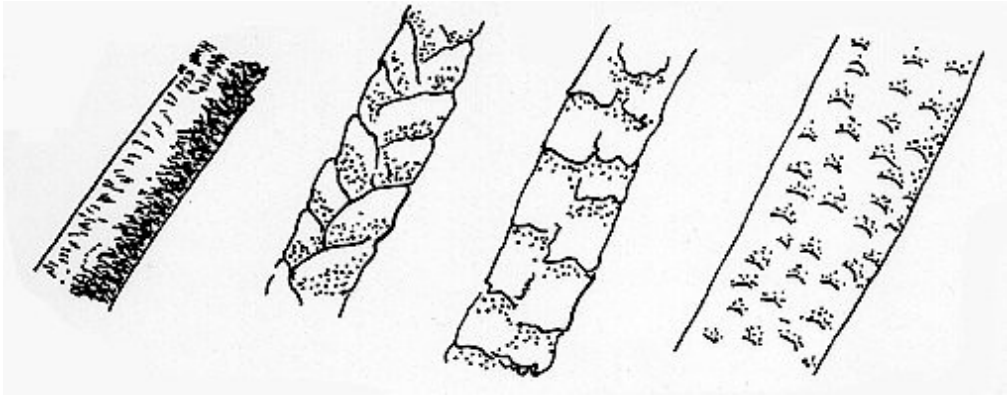
These days hair may be used to help identify individuals through DNA analysis. Traditional methods of hair analysis are still used as hair evidence will not always allow DNA analysis or the DNA analysis may be inconclusive or even not useful.
If physical analysis tells you the hair has no root material attached than DNA analysis will probably not be helpful.

If it tells you have dog hair, it is no use testing a suspect, though it might be worth testing his dog!

Hair Microscopy

Microscope examination of hair can determine the following information:

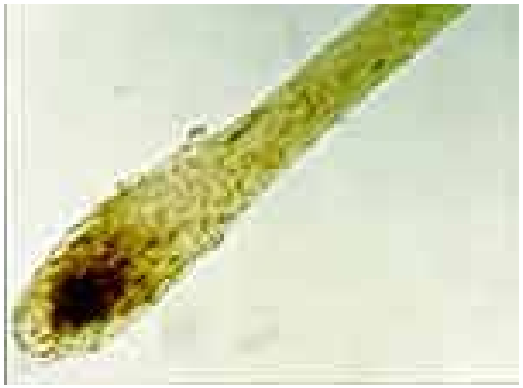
- Whether it is human or animal
- If human, which race
- If animal, which species
- Whether it fell out or was pulled
- The part of the body it came from
- How it was cut or dressed



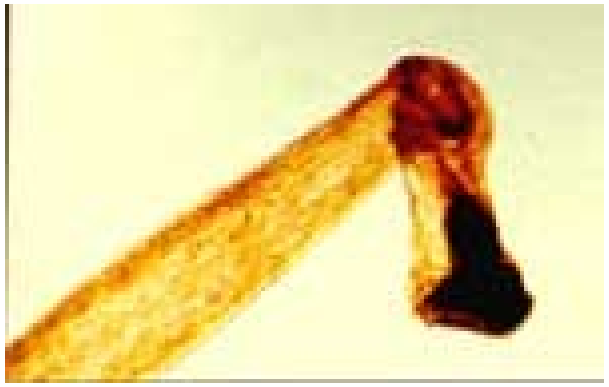
Human HH Cat Dog
Mouse

Hair Microscopy

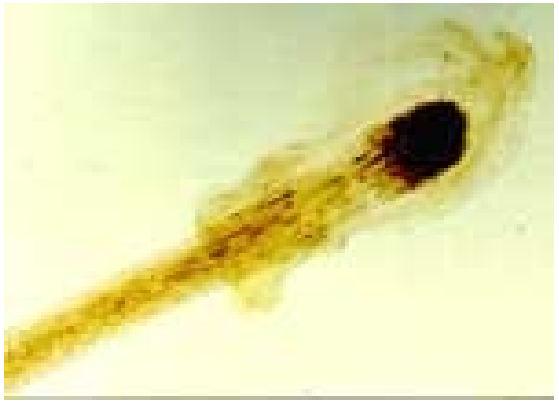
The examination of human hairs in the forensic laboratory is typically conducted through the use of light microscopy. This examination routinely involves the identification of questioned hairs and the comparison of questioned and known hairs.



Naturally shed hairs, such as a head hair dislodged through combing, display undamaged, club-shaped roots.



A hair forcibly removed from the scalp will exhibit stretching and damage to the root area.



Forcibly removed hairs may have tissue attached (for DNA analysis).

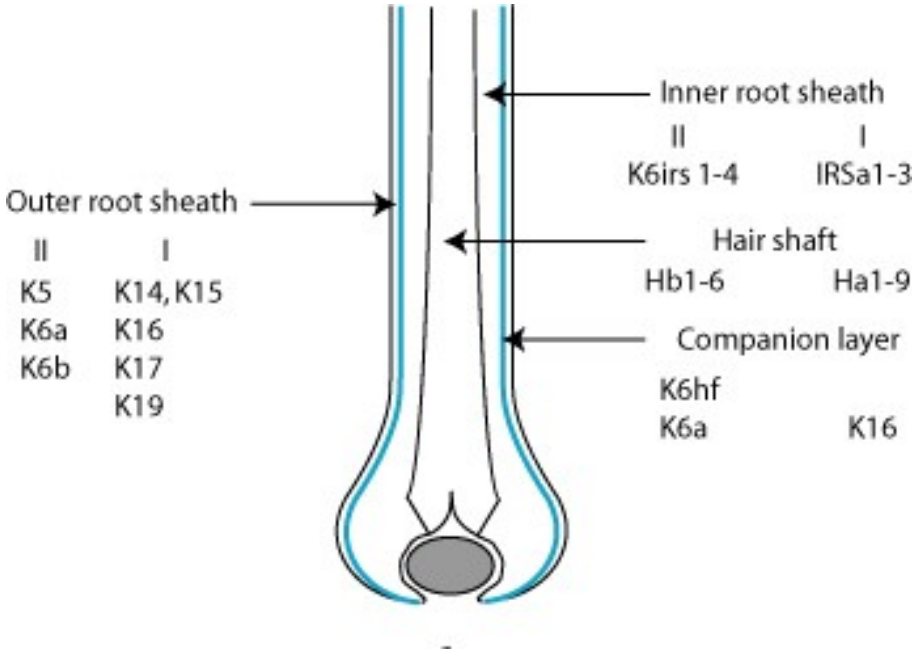
Hair Microscopy

Cuticle

- The outermost layer or sheath of the hair of mammals.

Cortex

- The main layer of the hair of mammals.



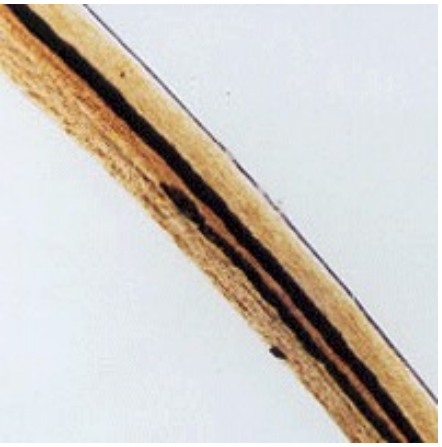
Keratin

- A tough, insoluble protein substance that is the chief structural constituent of hair, nails, horns & hooves.

Medulla

- The inner core of certain organs or body structures, such as the marrow of bone or centre of hair.

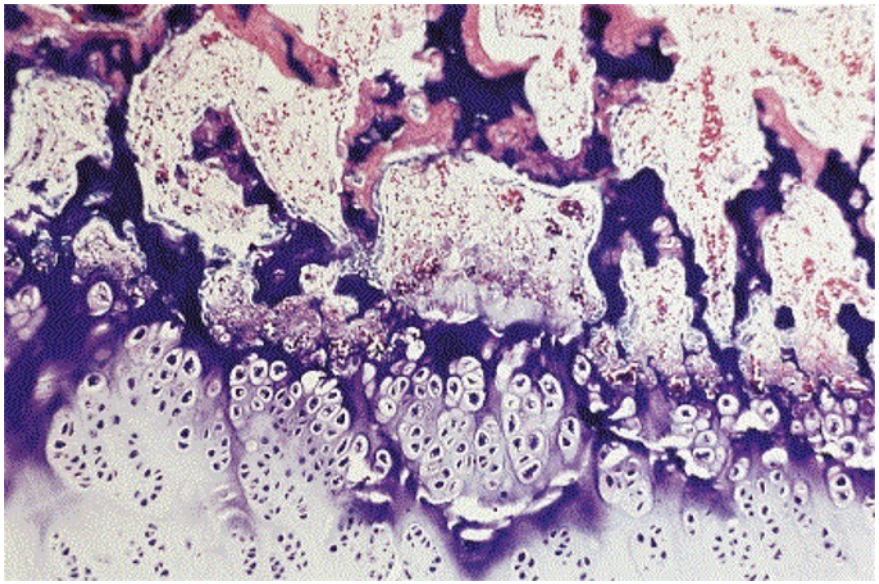
Hair Microscopy Classification

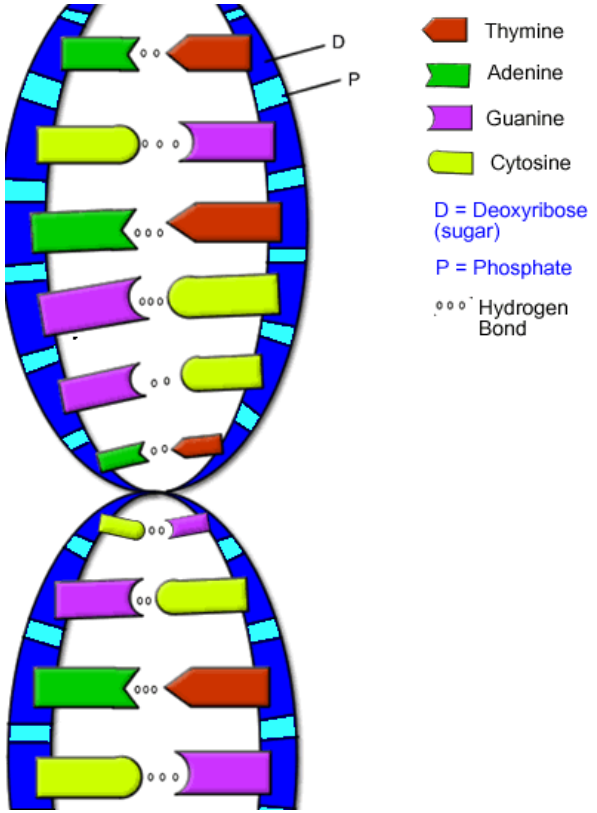


Two matching hairs identified with the comparison microscope

Root abundant fusi telogen anagen decomp stretched follicular tag Tip cut broken split pointed rounded Width coarse fine variation along shaft variation w/in sample Cuticle clarity color damage Scale protrusion slight medium large	Scale length short medium long Scale overlap slight medium large Cuticle thickness thin medium thick fluctuation Medulla absent translucent fragmented transparent discontinuous opaque continuous cell shape thick thin medium	Cortex cells Pigment size shape density distribution patchy streaky chaining Pigment gapping shallow medium deep short medium long Cosmetic bleached dyed time since treatment Special cracked ovoids double medulla diseases vermin Damage

Cells, tissue, DNA, Proteins





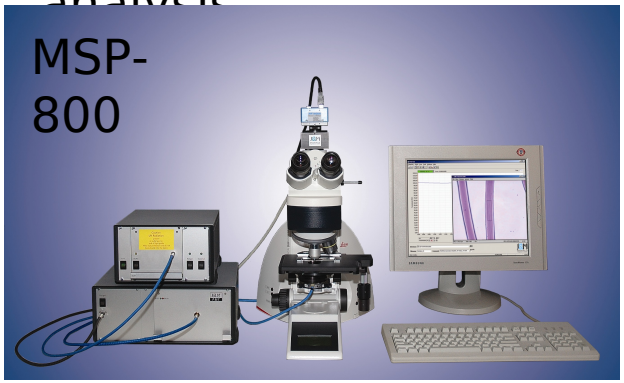
Same working concepts as in biological labs

Work principle: Hairs & Fibres

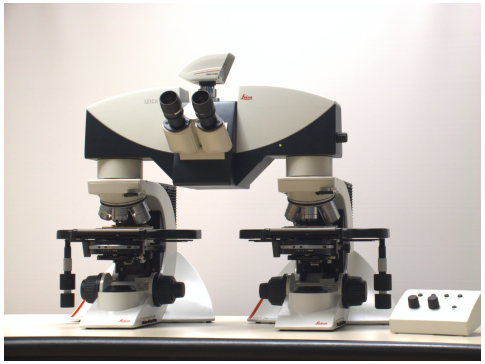
POL

Stereo / Macro

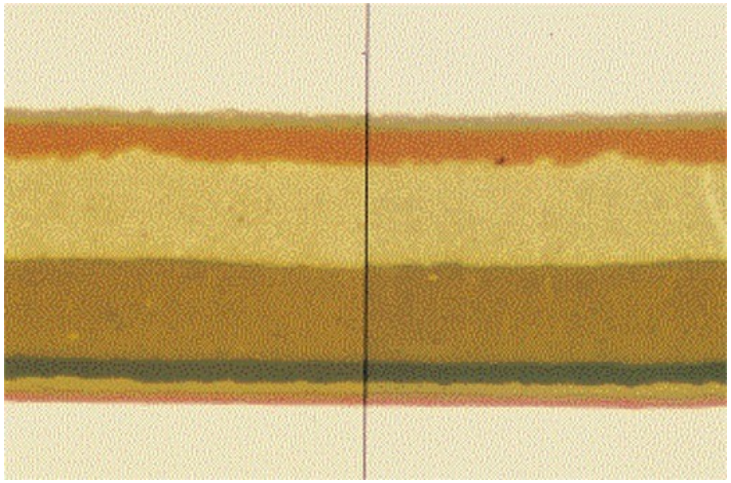
Spectra-analysis

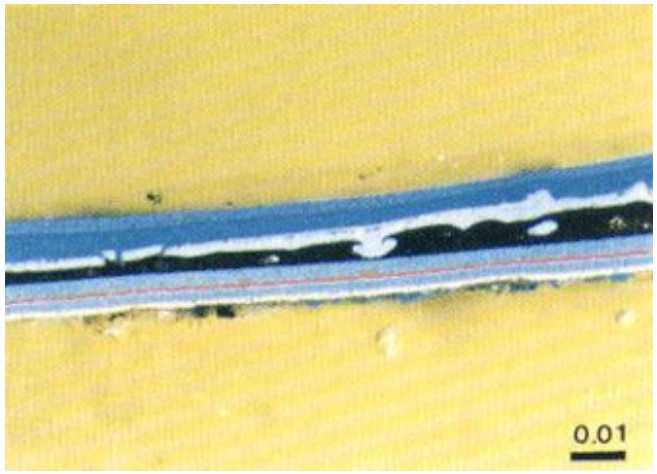


Comparison



Work principle: Paints





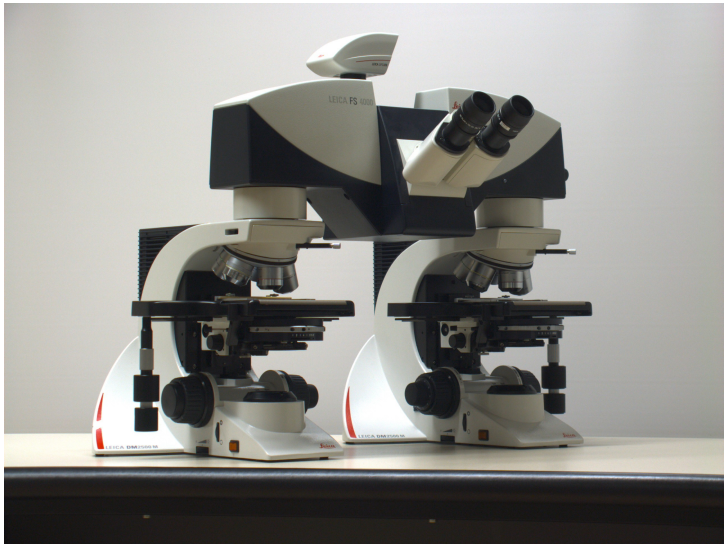
Same working concepts as for the fibers

➔ Sometimes same division

➔ Microscopy (25x to 1000x)

Two microscopes include:

- matching illumination systems
- stages (x-, y- movement, rotation)
- focus (z-control)
- optics (matched objectives)
- additional equipment (filters, etc.)



With one comparison bridge & one observation tube

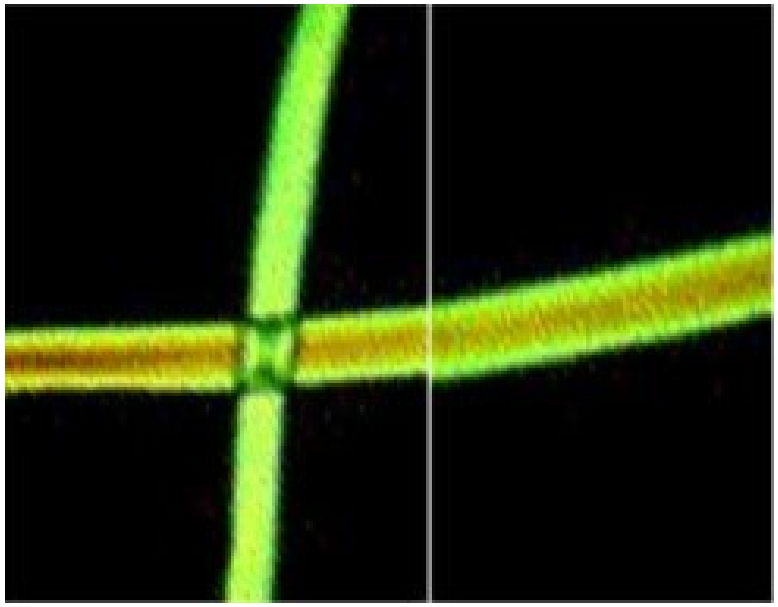
The Comparison Bridge

Comparison bridge

- prism to merge both optical paths

Two modes for viewing:

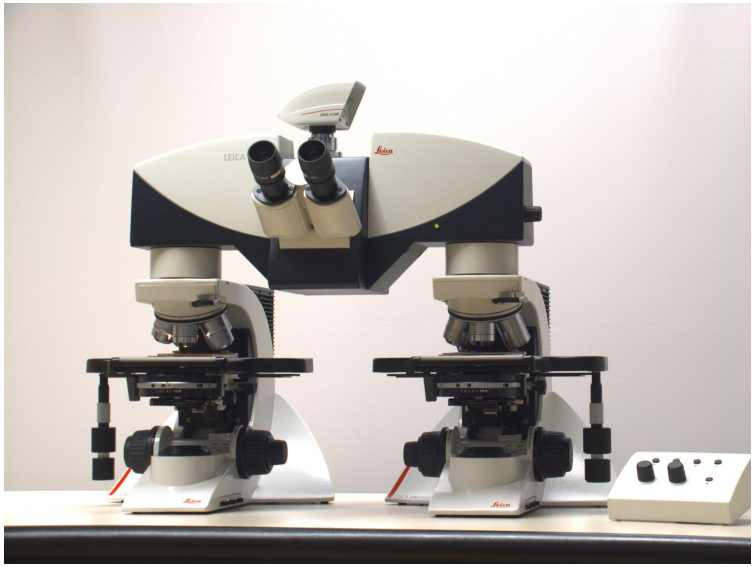
- split image (side by side)
- superimposed image



For trace evidence comparison analysis

Leica FS4000 motorized research-class microscopes

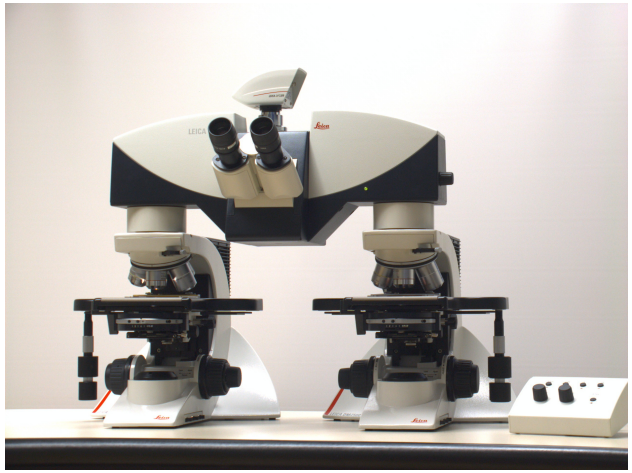
Leica FS2500 manual laboratory class microscopes



For comparison analysis

Comparison microscopes

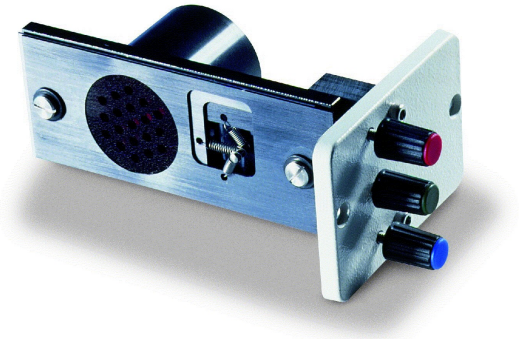
- Leica FS 4000 (BF, FLUO,M, POL)
- Leica FS 2500 (BF, FLUO, POL)

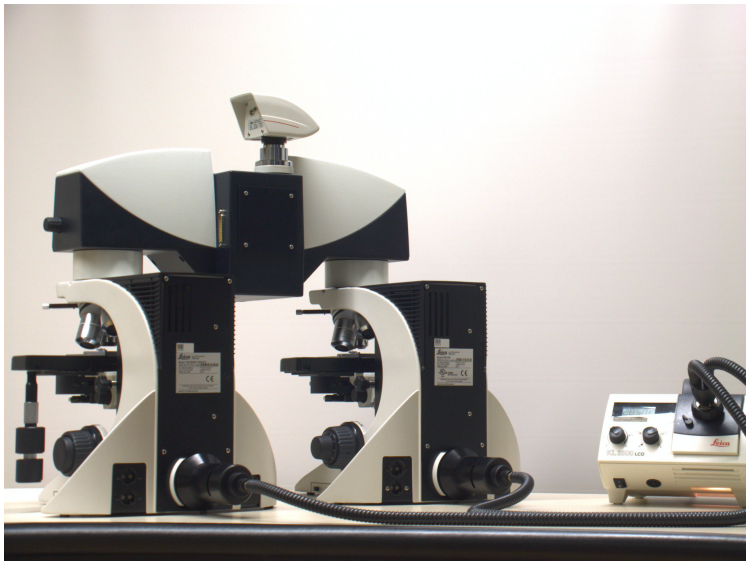


Leica FS 4000 / FS 2500 features

- Choice of Microscopes (DM 2500, DM4000)
- All possible contrasting techniques incl. new POL
- Fluorescence with 100W and 8 filters
- FL with EL 6000 Multipole & bifurcated fiber bundle

- Color compensation module (FS 4000)
- Superimposed image mode
- Fiber optics illumination system





Thank you for your attention