Thermal Microscopy in the Forensics Laboratory

Over the last few decades, forensic science has played an increasingly important role in tracking down criminals and narrowing-down the list of suspects that the police need to investigate. The ability to identify a suspect from a DNA sample has helped identify many suspects over the years, but DNA samples are not always left at a crime scene and with no DNA database, trace forensic evidence is often what will lead the police to a suspect.

After any DNA samples are taken from evidence left at a crime scene, the search is continued with a hunt for any distinguishing hairs, fibres and particles that do not seem to belong at the scene.

Senior Forensic Scientist, David Sugiyama works in the trace evidence section of the Tulsa Police Department Forensic Laboratory where they analyse hairs, fibres, paint and particles of glass found on suspects, victims and at crime scenes.

One of the distinguishing features of glass is its refractive index and Mr Sugiyama has found the Becke Line method for assessing a particles refractive index a fast and convenient way of telling if glass fragments found at a crime scene could be linked to a certain source. The key advantages of this technique are that it is non-destructive, relatively fast and inexpensive.

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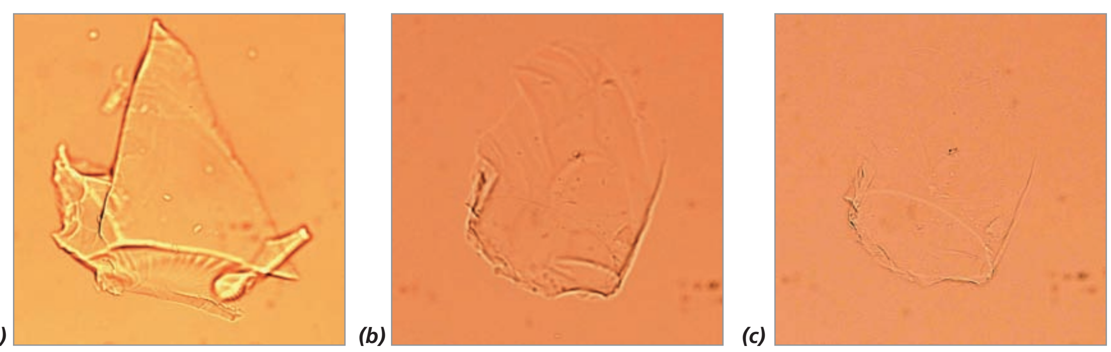
The Becke Line method involves placing a glass particle in a liquid of known refractive index and observing the direction in which the halo moves when the focal plane of the microscope is changed. The Becke Line moves towards material with the higher refractive index when the distance between the microscope objective and the sample is increased and towards the lower refractive index when the distance is decreased.

From left to right, the first two photos show a fragment of glass in a refractive index liquid. (a) "1.516 glass in 1.500" shows the Becke Line inside the piece of glass while (b) "1.516 glass in 1.524" shows the Becke Line outside the piece of glass. These show the correct orientation of the Becke Line which goes into the medium of higher refractive index when the distance between the piece of glass and the front of the objective lens is increased.

(c) just shows the piece of glass when it is focus, with no Becke Line observed.



Becke Line examples from the Tulsa Laboratory

If the glass has a similar refractive index close to that of a reference sample from the scene, the team then start more laborious analyses such as elemental analysis by energy dispersive X-ray spectroscopy (EDAX) and density determination.

The Tulsa Laboratory now uses a Linkam Examina THMS600 hot stage with TMS94 Temperature Programmer to go with its new Olympus BX-51 microscope (McCrone Microscopes & Accessories, Westmont, IL). This has allowed the team to make more accurate glass analyses than ever before. Images are recorded using a Leica DFC 290 digital camera.

Becke Line analysis typically involves using a series of liquids with different refractive indices to determine a refractive index range for the sample, not an absolute value. The refractive index of a liquid medium decreases as its temperature increases enabling forensic scientists to determine absolute values of a particle's refractive index. However, to be able to calculate accurate refractive index values, the temperature of the medium needs to be accurately controlled.

Linkam Tulsa system

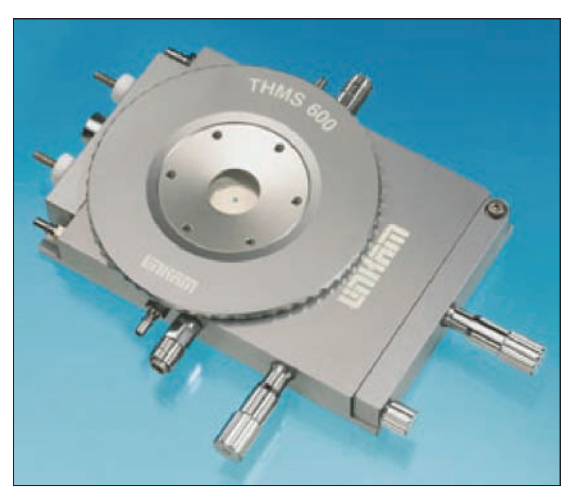
Using the Linkam hot stage, the Sugiyama Lab can now measure the refractive index of a piece of glass to an absolute value, accurate to 4 decimal places. Because the test is so accurate, the laboratory's glass reference samples have had to be replaced by better glass standards provided by NIST (the US National Institute of Standards and Technology).

The thermal stage has enabled the users to be able to use just one refractive index liquid, rather than trying to find those that are the closest match and made the technique into an excellent first screen to test for similarities between glass particles.

Of course, real life stories are never simple and even a match from one piece of evidence does not necessarily make a suspect guilty.

The system was applied in hit and run case where several witnesses were able to give a general description of a white jeep. This led to the police finding a white jeep matching the description with a smashed head lamp. On questioning, the suspect said he had hit a deer and had not bothered to replace the glass yet.

Analysis of the glass from the scene showed that from the headlamp had the same refractive index as those particles found on the suspect and further analysis indicated it was from the same source and could have been from the same headlamp. Upon closer inspection red stains were found on the particles taken from the car which were found to be blood. The samples were taken for DNA analysis and shown to be not human, leading the police to conclude that the suspect's story was true. The case against that suspect was dropped and police are now looking for a similar vehicle with glass from the same source as the Jeep.



Linkam Examina THMS600

CONCLUSIONS

In this example, temperature controlled microscopy was shown to aid forensic scientists to clear a suspect, a clear benefit of using the Examina system.

Acknowledgements:

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(http://www.tulsapolice.org/laboratory.html)