# A Forensic Look At Synchrotron Light

Forensic scientists have to think fast to keep ahead of criminals educated by *CSI* and similar television shows. Fortunately, the scientists haven't run out of ideas.

With the help of synchrotron light they are developing ways to detect antique forgeries from the chemical signatures of pigments, drug use from a single hair, and even a person's sex from a fingerprint. Similar techniques are contributing to occupational health and disease diagnosis. In most cases, the testing is non-destructive – an important issue in forensic work.

**Ivan Kempson analysing hair samples at the Ian Wark Institute.**
Photo: Sam Noonan

## Revealing Signatures

"Synchrotron light has a wide range of applications in forensic science around the world," says Mark Tobin, principal scientist for the Australian Synchrotron's infrared beamline. Some examples include:

- chemical analysis of pigments and inks to date historical documents, identify the source of the paint in an old painting or expose a forgery;
- analysing the chemical composition of your fingerprint to reveal your sex and approximate age; and
- analysis of contaminants in illegal drugs to show where the drugs were made. (US researchers have used trace metals in individual calcium grains to confirm that different drug seizures were from the same batch.)

The Australian Synchrotron is also on the case, with its infrared beamline already proving useful for forensic research and a microspectroscopy beamline, or microprobe, due for completion this year. For example, a team from Curtin University is using infrared techniques to investigate how ink interacts with paper. "That can tell you in which order pens were used, or if a signature was overwritten, suggesting fraud," says Tobin.

## What's in a Hair?

Last year a small section of skin from Australia's most famous racehorse, Phar Lap, was placed on a beamline at the giant Argonne synchrotron near Chicago. The scientists were looking for evidence of foul play – arsenic in the hair.

But arsenic was used in preserving Phar Lap's skin, so how would the scientists be able to tell the difference? The answer came from studies of the hair of smelter workers.

Ivan Kempson, a researcher at the Ian Wark Research Institute at the University of South Australia, led the investigation. "In the past, people tested relatively large samples of hair and estimated the lead contamination from that. We used synchrotron light to analyse individual hairs instead.

"The beamline is so fine – down to a tenth of a micrometre – that we can see where the lead has accumulated both across the hair and along its length. Most of the lead was on or near the surface of the hair – and this was largely associated with environmental contamination such as dust."

But the team also found deposits in the core of the hair, and under the skin, from lead that had clearly been absorbed into the bloodstream. This lead can cause real damage to a growing body.

"As a result of our work, people around the world are now reassessing how they measure heavy metal contaminants," says Kempson.

And what about Phar Lap? "We found a very high concentration of arsenic inside the hair just below the skin," Kempson says. "This suggests Phar Lap consumed the arsenic within a couple of days of his death."

Kempson's work is now heading in a new direction, focusing on the higher levels of zinc and copper many studies have found in the hair of people with autism or breast cancer. "The microspectroscopy beamline at the Australian Synchrotron will give us the resolution to determine how and where these metals are taken up in hair," he says. "If we can correct for variations like hair colour and use of chemical treatments, then we may have a new test for various diseases."

Don't send in your hair samples just yet. Any practical test would be 5–10 years away.

## Gunshot Residue

The Australian Synchrotron could also help solve gun crimes. When a gun is fired, minute particles less than 1/100th of a millimetre containing glass, organics and certain metals can stick to the gun, the shooter's hands or the victim. "The residue has a unique chemical signature, which is bad news for criminals."

Shipping Australian crime scene samples to an international synchrotron would not be practical. When the microspectroscopy beamline comes online later this year, it will bring synchrotron-sourced evidence to Australian courts.

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