Infrared detector unmasks cocaine addicts

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Hot on the trail of cocaine consumption: researchers from ETH Zurich are developing an infrared device that can detect cocaine in saliva. Credit: wikipedia

A research group at ETH Zurich is currently developing an infrared measuring technique to enable the detection of cocaine and its metabolites in saliva. The initial steps towards a portable measuring device have been successful.

If a police patrol stops a suspicious driver these days, he has to blow into the famous tube for an alcohol test. If the driver is suspected of having consumed illegal substances like cocaine, however, the officer has to order a complicated and expensive lab test to obtain quantitative results. A new approach could now make the process easier: a team of ETH-Zurich researchers headed by physics professor Markus Sigrist is currently developing a device to detect cocaine in saliva. “Our work is the basis for a compact device that law enforcement authorities can use 'in the field'," says Sigrist. This basis for rapid drug detection has just been presented in an article published in the journal *Drug Testing and Analysis*.

A few micrograms suffice

With the aid of so-called ATR infrared spectroscopy, the researchers have succeeded in detecting cocaine and a variety of its metabolic products in saliva reliably and currently up to a threshold of fewer than ten micrograms of cocaine per millilitre. Compared to the standard methods at toxicology labs, which can trace the drugs up to a threshold of one to five nanograms per millilitre, this limit of detection is still too high. However, the samples have to be prepared painstakingly and the apparatus is not transportable. The ATR-IR method is different: it is non-invasive and the saliva can be obtained easily and with little preparation. Moreover, the detection levels reached using ATR-IR spectroscopy are already accurate enough to take consumers of illegal drugs into custody directly after consumption. If someone smokes cocaine, for instance, up to 500 micrograms per millilitre are still present in the saliva a short time later.

Careful not to mix up cocaine and caffeine

The first important step for the ETH-Zurich physicists was to find out which wavelengths cocaine and its metabolic products absorb, so they examined the spectra that are characteristic and distinctive of these substances.

The physicists also had to determine the spectra of other substances present in the saliva. to make sure they do not overlap within the spectrum of cocaine. Consequently, they examined caffeine, extenders used to cut cocaine, mouthwash, painkillers, and energy and soft drinks. The researchers especially focused on alcohol. The result of this detective work was that the cocaine spectrum leaves behind distinct traces. The substance and its metabolic products absorb within a wavelength range of 5.55 to 5.84 micrometers. However, because water in the saliva absorbs the infrared light strongly, the researchers first extract the cocaine with a water-repellent solvent that then evaporates on the test apparatus.

More accurate detectors, better light

Meanwhile, Markus Sigrist and his team are in the process of refining and simplifying the procedure. For instance, they have also begun measuring cocaine directly in the liquid phase after extraction into the solvent. The physics professor also wants to reduce the detection threshold dramatically. He believes it is possible to detect amounts of twenty nanograms per millilitre of liquid using the infrared spectroscopy method. Apart from more sensitive IR detectors that are ten times more sensitive, the researchers therefore also require a new light source: a so-called "quantum cascade laser", which can generate infrared light within a narrow spectral band around a central wavelength of between four and fifteen micrometers. "This range is interesting for spectroscopy," says Sigrist. The initial experiments with this light source have been positive. It might also be possible to extend the drug test for the detection of other narcotics, such as heroin.

However, Markus Sigrist and his team will not be developing a market-ready, compact device, for instance, for law enforcement officers,: "We provide the basis and a sensor platform for such a device. It is up to an industrial partner to realize it," says the ETH-Zurich professor.

The detection of cocaine in saliva using infrared is a sub-project of IrSens conducted within the scope of the nationwide Swiss research initiative nano-tera. Besides Sigrist's team, the research group headed by ETH-Zurich professor Jérôme Faist which developed the quantum cascade laser and other teams, including detector specialists from the University of Neuchâtel, are also involved in the sub-project.

Infrared spectroscopy

The measurement method is based on ATR infrared spectroscopy (IR-ATR). ATR stands for "attenuated total reflection". This measurement technique was developed in 1960 and is used to examine the surfaces of opaque substances such as varnish or polymer foil. However, it can also be used to analyse liquid samples.

In IR-ATR, an infrared beam of light is directed into a crystal at a particular angle. The beam is reflected on both surfaces and thus crosses the entire crystal along a zigzag path before exiting it. The substances to be analysed are then applied to the upper surface of the crystal in an thin layer. The absorbed wavelengths are absent when the beam of light exits the crystal, which the researchers can measure.

More information: Hans KMC, Müller S & Sigrist MW. Infrared attenuated total reflection (IR-ATR) spectroscopy for detecting drugs in human saliva. *Drug Testing and Analysis* (2011), published online, doi: 10.1002/dta.346

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