

Fantastic FOURier

FTIR is a technology for the identification of hazardous chemicals and well-understood (by scientists at least). It gathers information on the molecular vibration of samples after interrogating them with an IR laser. The detectors most commonly found on the crime scene, or even battlefield, are either Smiths Detection's HazMat ID or Bruker's Rapid system. While the two of them both use FTIR they are fundamentally different detectors: the former is a point detector that requires the sample to be introduced to it, while the latter is a passive stand-off detector. The two of them they have constituted the market for FTIR detectors for the past five years – even to the extent of Smiths and Bruker signing a marketing partnership (for the promotion of each other's products) in 2003. Recently this has changed – in a big way. Not only are Smiths now competing with Ahura Scientific for the point detection and Bruker with Bertin and Avir Sensors on stand-off, but Smiths and Bruker now have competing products in each other's markets. What has driven this sudden surge in the market?

It certainly isn't the technology. FTIR has been around for 40 or 50 years in the laboratory, and even the rugged field versions have been around for five years. So while there has been some work done on making it soldier/cop-proof, it clearly is not a case of the technology coming of age.

"FTIR has been in use for quite a long time, but the application for the market that we are interested in has

only really emerged since 9/11," said Sebastian Meyer Plath, Managing Director of Bruker Daltonics. "Before that there was no need to deal with white substances coming from envelopes – that triggered it. What would be small enough to be practical – and FTIR can be done quite small – and can be used without an inlet – like you need to with IMS or GCMS? It can also be kept fairly simple, decontaminated and rapid, so that is why the technology came into use. A few companies like SensIR saw that quickly and came up with a product, whereas other companies, like Bruker, only became interested after the other companies enjoyed their success. Smiths, through SensIR, showed that the market is quite big, which is why Bruker became interested in coming up with a product. Both Bruker and Ahura have a 'Me Too' product."

As Sebastian Meyer Plath suggests, it is the market that has allowed HazMat ID – and by extension FTIR – to become mature. The need for on-site analysis gave serious organised crime officers and others involved in counter-terrorism a need that FTIR could fill – that other technology like IMS could not. The sudden embrace of FTIR seemingly was a bit of surprise to the big companies, such as Smiths and Bruker, as neither of them had organic products, and Smiths' HazmatID came from the purchase of the original producer of it – SensIR in June 2004.

This ability to hit the ground running clearly paid Smiths dividends, since they managed to have the market

to themselves for four years – as Aaron Gagnon, Smiths Detection's Director Product Management for Global Military and Emergency Responders, agreed: "At that point we had the right product at the right time and we did fairly well. HazMatID was sealed for decon, offered a protein screen for biological agents, and armed responder's with confidence to make decisions on-scene. All this time we have been growing the IR library on our own platform, which is a proven strength. IR spectra are like the FBI labs of fingerprints. Like fingerprints, every chemical is unique. To date, the HazMatID enables responders to identify more than 34,000 materials in seconds utilizing its large onboard IR database. This is an important advantage in emergency response and it has played a key role in the product's worldwide success."

In trying to differentiate between Smiths' HazMat ID, Bruker's Mobile IR and Ahura's TruDefender FT, the database is probably the easiest way to do it. There is some value to using quantity of substances identified too. One of the main roles of these detectors is to tell the user exactly what the unknown substance is. While there might be some consolation in knowing that it is not an organophosphate, blood or blister agent, there are plenty of toxic industrial chemicals which are unpleasant that don't fit into those categories – so the wider the net, the better the detector. This is certainly the philosophy that Smiths and Bruker fit into. "Databases are critical to the

system,” agreed Aaron Gagnon, “and that is why we work so carefully with chemical companies to expand the library to include explosives, narcotics and chemical warfare agents. You can also send it remotely, or wirelessly, using the world-wide web, to our reachback 24/7, 365 days a year, support to further examine the data that comes off the system.”

Bruker’s Managing Director felt that the ease of availability of FTIR spectra, however, stopped it becoming too much of a distinguishing factor. “The databases are readily available, standard FTIR databases. You don’t need to tailor the DB – you don’t need to measure all the spectra, you can buy these and they usually look the same. You can use a commercially available FTIR database to have a starting point and from there you have to make a decision as to which ones are interesting.”

Ahura, however, have a completely different view of the issue. One of the problems with FTIR as a technology is that it is not particularly good at dealing with mixes, or samples complicated with other “interferents”. Ahura don’t try and do the quantitative approach, countering Smiths’ 35,000 samples with only 1,500; for them it is a qualitative process. “The meaningful analysis of data and analysis of mixtures is what the product sells on,” said Duane Sword, Ahura’s Vice President of Product Management. “This is where we will differentiate and put our engineering effort – we can identify and disseminate five mixtures. It could be more but the library is built on spectral information that has been built on our platforms, and by design we cannot allow importing of other spectral labs. There are other vendors and equipment out there that make the importing of libraries into a feature, but you don’t know under what conditions it was collected, how it was calibrated, etc. Every one of our library item has been developed on our platform. It doesn’t have to be developed by us, our clients build more library items than we do. But every time an item is added to the library you are making the mixture analysis more complex, because now you are looking at all the peaks and all the troughs of that spectral chemical fingerprint, and all the combinations of

Ahura's TruDefender FT has taken FTIR down to its smallest size yet.
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chemicals, to make out what are the unique attributes of the chemical structure you are looking at. We can continue to add libraries, but making sure that we do not deteriorate the mixture analysis is a fundamental part of what we want to do. The other part of it is speed. We are building libraries on commercially available processors, so we want to do it in seconds. It is not a list of things that it could be, it is not a list of things that it is probably, we want to provide clear guidance without ambiguity. If we can't do that it will say No Match Found, use reachback and give answers in minutes.

"There are different philosophies and it is difficult for me to say what is right and wrong," continued Mr Sword. "Our target user doesn't have a chemistry background, they are in combat, or have a lot of things going on, and want to trust the instrument in their hand to give them guidance so that they can get out of there. Taking a sample, getting a list of stuff that it might be... I am not sure that that is so useful. Is there everything in the library? No. Is there everything that is predominantly out there in the library? Yes, and if they are not there from us then our three-letter acronym customers will have put them there based on their experiences. We are not allowing third-party labs to import spectra and never will as we want to have the qualitative hit-quality index answer and our philosophy is answers with confidence rather than a degree of probability. We add about 5-600 items on the library every three months and they are added to the product offering free of charge."

Ahura's TruDefender FT uses a chemometric system, to give clear, colour-coded guidance to the user about what he is seeing, as Duane Sword explained. "Chemometrics allows us to present meaningful information that can be acted upon without extensive chemical knowledge. Accuracy, precision, and speed are the key themes for our product development effort, providing dependable guidance our customers know they can rely on. At Ahura Scientific, we haven't just focused on what's inside the box; we have looked at the box itself. This isn't a lunch-box

sized instrument designed for scientists; it is a handheld tool designed to give guidance, quickly, to first responders in the field."

Bruker have a more direct approach to what makes their Mobile IR a competitor. "Bruker's advantage is the robustness of the system itself: we are using the trademarked 'rock solid' interferometer. Price is another selling point – we are cheaper than HazMat ID – and the availability of special

software and algorithms which were developed for lab use makes it much easier to use the system in conjunction with reachback," concluded Sebastian Meyer Plath.

Smiths is not sitting on its hands in this market, however. Seeing which way the wind was blowing with Ahura's TruDefender FT, they have also launched a handheld FTIR detector. "We have just released the HazMat ID Ranger," said Aaron Gagnon, "this is a smaller,



New Nato nations, like Romania, are procuring stand-off detectors far faster than established Nato countries ©CBRNe World

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Smiths Detection's first foray into Stand off detection, with Telops, has stalled, who will their new partner be? ©CBRNe World

miniaturised FTIR. We have shrunk the IR tech and the electronics and made it so that the system can then be more portable and brought more easily to the sample in extreme applications so that, if the customer is using it in mountains or deserts, it brings increased portability to the HazMat ID family of products."

Yet it is not just in the point FTIR detectors that there has been increased competition. In 2006 Smiths, in conjunction with Telops - launched their stand-off FTIR detector. This partnership was, however, short-lived, but Smiths remains committed to the stand-off market, as Rod Wilson, Smiths' Director of Marketing, explained: "Stand-off detection is a clear emerging capability requirement for chemical detection. The technology, however, is immature and needs careful review and consideration to meet the expectations of potential users. There are opportunities in this area if the right technology is available. To this end the US DoD are formulating a programme which takes a system of systems approach to providing an early-warning capability: a stand-off chemical detector is seen as an integral part of providing this capability. Our belief is that Stand Off passive Infra Red technologies are the best match to this problem currently available and we have

been interested in this technology for a number of years. Smiths are very keen to be involved in this programme and are actively putting together our approach."

While Avir Sensors, Bertin and Vojensky Technick Ustav are marketing stand-off detectors, Bruker retains the most dedicated and mature passive FTIR product. Yet, while the US DoD tinkers around the edges, there are very few Western European Union countries (usually the second biggest market) embracing stand-off. Many of them seem to put the tick in the "Would be nice to have" rather than the "Must Have" box.

Sebastian Meyer Plath disagreed: "There are countries that are using stand-off and they have it in their 'must have' requirement box. That includes UAE, Japan, India - they all have military stand-off tech as a must have. Also new Nato countries Romania, Poland, Slovenia all want it or have it. Their motives from country to country are quite different, however. If you take India, they have tried to get their indigenous chemical detection capability to do it for decades without success; now they have made the decision that they need to get technology in from outside and then,

based on their experiences on that foreign technology, will build their own in the next 30 years. So they want to get the most advanced tech into their country as quickly as possible, which is why they are looking at state of the art in terms of application. New Nato, because they didn't have anything up to Nato standard, were more flexible in regards procuring new detector technology. They were also the flexible components in making sure that Nato doctrine was adapted to use these new detectors - as opposed to when we launched our Bruker Rapid a couple of years ago and Nato sloped shoulders and said we don't have the right doctrine and tactics to use it. That meant everyone turned away and said, 'No Nato country will buy that.' That changed and one of the reasons for that is new Nato countries embraced new technology as they had nothing and have gone a further step, while established countries are more fixed in procedures and can't be that flexible."

Rod Wilson stated that, in his opinion, the US would be the most significant opportunity for this product type, and this would be where Smiths would be putting their efforts, and it is easy to see why. The US certainly has an infatuation with stand-off, whether it be CB or R, and the money is there to fund further research - as opposed to off-the-shelf products. FTIR is generally seen to be a complementary product, however, as it does have well-understood drawbacks. So at point detection it is usually used in conjunction with raman spectroscopy and currently for stand-off the needs of triangulation, and eradication of false positives, means that the system is used in pairs - but in the future it may well be that there is a combination of passive and active systems (to allow greater interrogation of the cloud). Much like IMS there is little more that can be done on FTIR, some tinkering around the edges, but it is certainly not going to be "the detector of tomorrow". Instead, it is a technology that has been market driven. But now that the market has its foot on the accelerator, industry will, no doubt, increase invention to differentiate and capture market share from their rivals.