SensorHut Ltd

Nano-structured optical chemical sensor

SENSORHUT

SensorHut Ltd has developed a new sensing technology that uses optical techniques to improve significantly detection of volatile organic compounds (VOCs)

Key facts/data:
SensorHut Ltd

Technology: Optical sensor for volatile organic compounds

Established: 2013

Type: Spinout

Location: Cambridge

Employees: 2

CEO: Dr Tanya Hutter

Tanya Hutter is a Darwin College research fellow at the Department of Chemistry. She obtained her PhD in Physical Chemistry from the University of Cambridge in 2013 after undergraduate studies in Chemical Engineering at Ben-Gurion University in Israel, followed by a Masters in Materials Science and Engineering from Tel Aviv University. She co-founded SensorHut at the end of 2013.

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Choice of Cambridge

Cambridge University has spun out several successful sensor companies. However, this was not the original reason that Tanya Hutter, co-founder of SensorHut, came to Cambridge for her PhD. Firstly, she arrived with no aspirations to start a company, or even to go into business. Secondly, she had had several offers from universities in Europe having published highly cited papers on her subject of optical sensing during her MSc at Tel Aviv University. She chose Cambridge chiefly because of the English language and the generosity of the scholarship offered by Trinity College.

Optics decision

The decision to combine her Chemical Engineering studies with Electro-Optics was influenced by a job at a pharmaceutical plant in Israel. After three months' experience of working in an industrial environment she was certain that academia was a more stimulating and better choice for her. As a result, she applied for a MSc in Materials Science and Engineering, and found a research supervisor at the Department of Electrical Engineering. This began her interest in physics, optics, lasers and nanotechnology.

Entrepreneurial seeds

When she came to Cambridge in 2009 her range of scientific interests allowed her to engage with many different departments. It helped too that the University has a well-established cross-disciplinary sensor networking organisation, CamBridgeSens (www.sensors.cam.ac.uk). At that time CamBridgeSens had funding available for projects from the government's science funding agency, EPSRC. Hutter made an application jointly with researchers at the Electrical Engineering Department which won a £30,000 grant for development of an integrated waveguide sensor. It gave Hutter an insight into how to fund research working with collaborators and kindled the beginnings of an entrepreneurial interest, which, surprisingly she acknowledges, had lain dormant in Israel, despite the fact spinouts from Israeli universities are more common than they are even in the UK.

CEO, Dr Tanya Hutter

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Entrepreneur programmes

What stimulated her entrepreneurial genes further was discovering that Cambridge offers a multitude of opportunities for those with a desire to make their research commercial. “I was brainwashed, there was so much being offered”, she says jokingly. In the summer of 2011 she joined the annual Ignite Programme, run by the Judge Business School, the cost of which was covered by a payment from the Cambridge Integrated Knowledge Centre (www-cikc.eng.cam.ac.uk). Another source of entrepreneurial stimulation was the ‘Enterprise Tuesday’ evenings held every week during term time, as well as many Entrepreneurship workshops and seminars offered by the University.

i-Teams Cambridge

Hutter joined a programme, called i-Teams (iteamsonline.org) which allows students and postdocs to work together on finding real applications for university inventions. After submitting her sensor technology idea the organizers matched suitable people to work with her in a ‘team’. By the end of the programme the team was able to demonstrate that they had clear interest from at least ten industrial companies interested in the potential of the technology. One of the team members, Marc Stettler, who was doing a PhD in Engineering, became a co-founder of SensorHut.

Judge Business School and Accelerate Cambridge

The Judge Business School is another key source of support for start ups in Cambridge. Much of its work with entrepreneurs is due to the pioneering work of the former head of the Centre for Entrepreneurial Learning, Shai Vyakarnam, who we featured in Issue 16 of inside:technology. One of its latest programmes is called ‘Accelerate Cambridge’ (www.jbs.cam.ac.uk/entrepreneurship/programmes/accelerate-cambridge).

SensorHut joined the programme in January 2014, which provided three months of intensive mentoring from faculty members and the Judge Business School’s mentors’ network, along with hot desking facilities. As a member of the programme, SensorHut continues to have access to all workshop events and mentoring sessions.

Funding

Hutter and her co-founder, Marc Stettler, incorporated SensorHut at the end of 2013. They then entered several student-run competitions at the University, which earned small amounts of prize money. They were also awarded £15,000 seed-funding from the Judge Business School which allowed them to match-fund several Innovate UK grants, including SMART Proof-of-Market and Technology Inspired Innovation.

Prototype

The government grants provided the funding to patent the technology and build their first prototype and produce proof-of-concept results. Like everything else building the prototype was done on a highly restricted budget, buying second-hand equipment off eBay and employing interns with the help of an intern programme run by Santander Bank, called the ‘Universities SME Internship Programme’.

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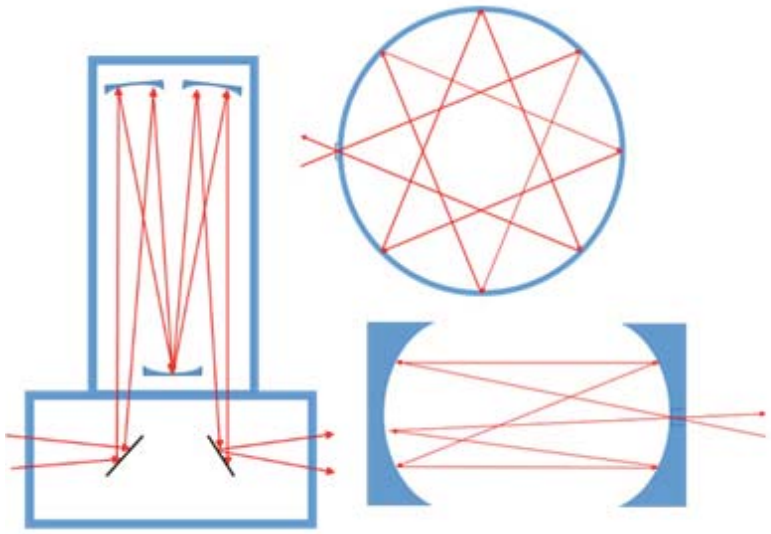
About the sensor technology

Standard optical sensors based on spectroscopy rely on light interaction with the gas molecules. The sensitivity, and the detection level, depend on the interaction path-length. The longer the path-length, the stronger the signal. In order to increase the path-length, special multi-pass cells have to be designed which require expensive mirrors and careful optical alignment [see illustration]. This arrangement increases the cost and the size of the system.

SensorHut takes a very different approach; instead of measuring light-matter interaction in free-space, it measures it through an optical nano-structure. The nano-structure behaves like a molecular 'sponge' to concentrate volatile organic compounds from the air. According to SensorHut this arrangement increases the sensitivity by three orders of magnitude. Such a significant improvement in sensitivity results in lower detection limits (ability to measure very small concentrations) and significantly smaller path-lengths compared to standard free-space IR sensors, thus enabling sensor miniaturization.

The nano-structured sensor surface can also be chemically modified to give a preference for concentrating one type of molecule rather than another, thus increasing the selectivity of detection. For example, if there are two types of molecules in the air: 99% of water and 1% of hydrocarbon, water absorption peaks will saturate the optical spectrum and the hydrocarbon spectrum will not be clearly seen. SensorHut can make the 'sponge' hydrophobic, in order to concentrate only hydrocarbons, and therefore provide more accurate measurement.

Standard multi-pass cells



- Optical alignment
- Bulky
- Expensive

SensorHut's approach

- Robust
- Small
- Cheap

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Miniaturisation

SensorHut's technology enable measurements which are not possible with standard free-space spectroscopy. For example, near-IR spectroscopy is widely used in the process industry for solids and liquids, but has not been widely used for gas analysis due to low sample density and the relative weakness of the spectral features. Normally, a long path-length is needed to perform the gas measurement in the ppm level (optical path length of 10 - 40 cm or more). SensorHut's technology makes it possible to reduce the path-length for the measurement of low-concentration of volatile organic compounds, and therefore enables near-IR spectroscopy to be used as a small sensor, such as a probe which can be placed inside a reactor for continuous monitoring.

Key advantages of the technology include:

- Miniaturisation: from a path length of meters to below a centimetre
- Improved sensitivity
- Improved selectivity
- Remote measurement: de-coupling of electrical components from sensor head enables measurements at distance via optical fibre
- Wide concentration measurement range which can be tuned in real time
- Ease of use: no sample preparation is required; sensor can be placed in reactor, pipe, etc.

The sensor can be used for:

- Air Quality Monitoring
- Industrial Safety and Personal Safety in hazardous environments
- Chemical Process Monitoring
- Homeland Security

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Chemical sensor market

SensorHut sees market demand for chemical sensors being driven by continuous technology innovations and expanding application areas. They expect chemical sensors based on emerging technologies, such as optical sensors, will see the fastest gains with strong growth in all chemical sensor outlets, including industrial and environmental applications.

Air quality and safety

Air quality monitoring is one of the growth markets due to increased air pollution and health concerns. For industrial safety and worker exposure, there is a strong need for sensing toxic organic volatiles which are commonly encountered as petroleum products, solvents and fuels. This includes specific toxic substances such as benzene, toluene, ethylbenzene and xylenes, butadiene, hexane and formaldehyde. Increased awareness of the toxicity of these common contaminants has led to stricter exposure limits and increased requirements for direct measurement of them.

Chemical process monitoring

SensorHut foresee a need for real-time chemical sensing as chemical companies move from batch production to continuous production. Currently companies still take samples manually from the reactor to the lab for analysis, which is both labour intensive and delays measurement results. SensorHut's technology can be implemented in the headspace of a reactor to monitor the volatile molecules associated with the process. For example, during polymer production, the concentration of the volatile monomers decreases as the polymerization progresses. Real-time monitoring of the monomer can provide valuable information on how the process progresses and when it is finished. Another advantage of headspace measurement is that sensors placed in liquid phase are easily contaminated and only measure at one single point in the reactor which might not represent accurately the overall reaction status.

Vision

Hutter's goal is to build an R&D focused company and to develop a series of products from their platform technology. She also wants to establish a nano-material manufacturing facility in the Cambridge area. Recognition of what SensorHut and Hutter have achieved has arrived with Awards from the Royal Society of Chemistry (Emerging Technologies Competition 2016) and L'Oréal-UNESCO UK and Ireland (For Women in Science programme 2016) in recognition of her academic work and achievements.

Dr Tanya Hutter at Royal Society of Chemistry Awards Ceremony

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Partnership

To go forward Hutter is keen to work with an industrial partner who will invest and co-develop new products; she also wants to find end-users who wish to incorporate SensorHut's technology to improve their chemical processes by detecting low concentration VOCs. She is currently in discussions to build first products with Alphasense Ltd, a leading UK gas sensor R&D and manufacturing company, which is focusing on the industrial safety and air quality markets.

Valley of Death

Hutter is uncertain whether she can call herself a 'real' entrepreneur yet, but she is quite certain that she is "very good" at the translation stage of applying academic research to practical applications. Her near-term goal is to have funding in place so that she can test her entrepreneurial potential by bringing a product to market within 12-18 months of the funding. The 'valley of death' is ahead and on the other side is the possibility of joining the ranks of other successful sensor spinouts from the University. ■

www.sensorhut.com