Science

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Cambridge Independent ENTREPRENEURIAL SCIENCE & TECHNOLOGY AWARDS

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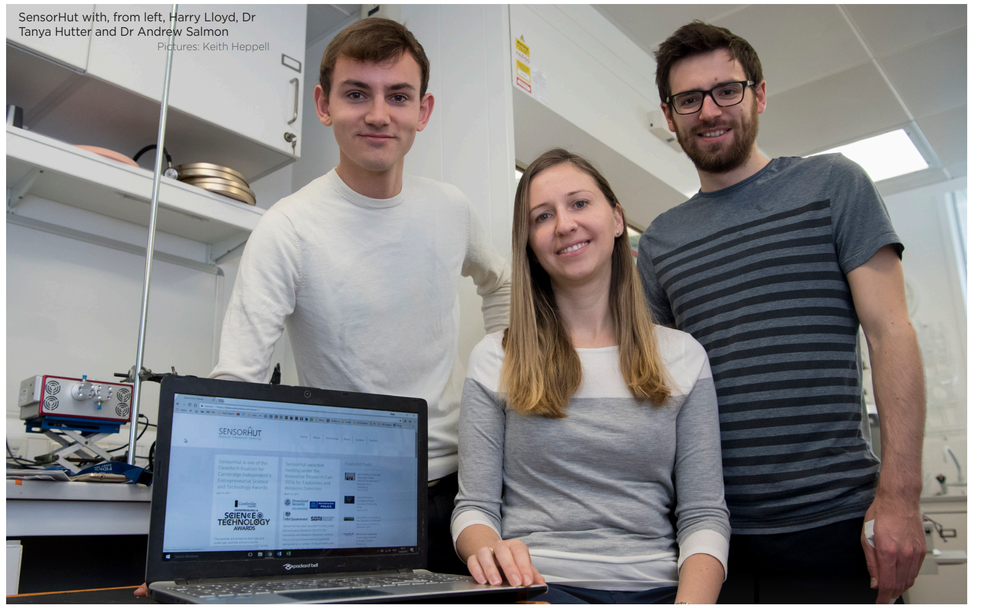
Sensing the future... with a nanosponge

From monitoring air quality to detecting explosives, SensorHut is creating nanotechnology that can make a difference. Continuing our focus on finalists in the Cambridge Independent's Entrepreneurial Science and Technology Awards, editor PAUL BRACKLEY spoke to co-founder Dr Tanya Hutter.



SensorHut with, from left, Harry Lloyd, Dr Tanya Hutter and Dr Andrew Salmon
Pictures: Keith Heppell

Dr Tanya Hutter has a steak in the lab. It's not that we're interrupting her lunch. Rather, she is exploring whether her patent-pending gas-sensing technology could be used to tell you when the meat in your fridge has gone off.

It's just one of a myriad of ways that SensorHut's ingenious combination of chemistry and nanotechnology could soon be deployed. From measuring industrial processes to monitoring air quality indoors or outside, it offers 1,000 times the sensitivity of traditional optical sensing. "I come from a research background," says Dr Hutter, who has 10 years' experience in sensors. "This is an idea I had during my PhD at Cambridge, but that was on a slightly different subject, so I didn't pursue it. When I finished I thought I would give it a go."

Cambridge Accelerate, the venture creation programme at Cambridge Judge Business School, was recruiting its second cohort at the time. "I wasn't sure whether I should start a company but I joined and they encouraged me to pursue it," said Dr Hutter. "From my research I knew there was a challenge in detecting certain molecules and the concept combined several disciplines, which was unique.

Sensors can be used in fridges to detect rotten food

"I spent the next year trying to explore whether there was a market. By talking to people and companies, and doing market research, I convinced myself there was a market.

"When I started the company I just had the idea. So it was a challenge to get the money and the expensive equipment required for nanotechnology research, so I got a job at the university as a post-doc and combined both."

With some seed funding from the Judge Business School, consultancy work and support from Innovate UK, Dr Hutter gradually made progress and then secured funding from Alphasense, who were keen on her technology. Alphasense Ltd is a leading UK gas sensor R&D and manufacturing company, which is focusing on the industrial safety and air quality markets.

Volatile organic compounds (VOCs) are all around us. Some occur naturally, while others are man-made. And some of these VOCs are harmful to humans and the environment. Take formaldehyde, for example. Found in cigarette smoke and used in the production of plastics, carpets and resins, it is a known carcinogen. Benzene, also a known carcinogen, lingers around very fuel station in varying concentrations.

There's growing demand to measure such compounds, but monitoring them isn't straight-forward. Existing detection technologies are limited, and struggle to differentiate between chemically similar compounds and providing only the total concentration of VOCs. Optical sensors based on spectroscopy offer many advantages, especially the ability to differentiate the large families of VOCs.

Cambridge-based SensorHut uses nanophotonics to miniaturise the sensing technology. Instead of shining the light through the gas for metres, the light needs to travel less than a centimetre.

"We use a nanosponge, which has very high surface area, that absorbs volatile organic compounds. And we shine light not through the gas but through the nanosponge. So we concentrate the molecules and measure them in real-time," says Dr Hutter. "Seeing the results benchmarked against standard optical measurement was a milestone."

The method is not only more sensitive, but can also improve the selectivity of detection. "We can make the nanomaterial with different surface chemistries, for example make it more hydrophilic. We can make it prefer one type of molecule more than another so it acts like a filter, increasing the selectivity compared to standard optical spectroscopic methods," explains Dr Hutter.

"With spectroscopy, you'll often have water interference but we can change the surface chemistry of the sponge, selectively filtering the molecules.

"We have competition with companies using other sensing technologies, but there is room for many companies because each gas sensor is optimised for a certain family of molecules or application. No gas sensor is best for everything, so we're all targeting different markets where our technology is the leader."

> ***We are also looking into benzene and formaldehyde sensors because there is an established market... It's exciting because I've got to do things I've never done before, like starting a company, talking to investors and learning how to pitch, and understanding what business is like***
> **Dr Tanya Hutter**
> Co-founder, SensorHut

The chemical sensing market is estimated at $20billion and growing, thanks to stricter health and safety regulations, the demand to improve industrial efficiency and increased monitoring and the enforcement of environmental pollutants.

SensorHut's technology can be used to monitor chemical reactors and pipelines and can help drive forward the Internet of Things, with connected devices giving real time feedback.

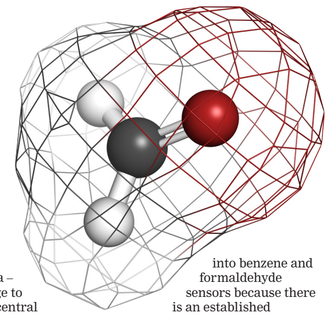
"The chemical industry is moving towards 'flow chemistry' where, instead of batch reactions – one by one – you are continuously generating your chemical. Here, the sensors can be used in-line, for real-time measurement," says Dr Hutter.

SensorHut is also exploring another potentially critical market. "We have a grant from the government for explosives detection. We are looking into the possibility and it's ongoing – we don't have the results yet. There is a lot of R&D to do, but it could be used at airports, border control or crime scenes.

"Other applications include measuring indoor, cabin and urban air quality. There are already sensors measuring small gas molecules like ozone and carbon dioxide. But we are measuring different compounds – VOCs, like benzene, toluene, hydrocarbons and formaldehyde; the sensors now available to measure these molecules can only tell you the total concentration of VOCs without telling you what is the molecule. You don't know if they are harmful and what is their chemical composition – you do not get that information at the moment with low-cost sensors. "We are trying to position ourselves between the low-cost sensors that only give you a total concentration and the other end with bigger equipment that gives you a whole variety but are more expensive."

While there has been much recent focus on air quality in our cities, there is also concern over the levels of toxic chemicals in our homes and offices – and their concentrations there can be much higher indoors. "They are everywhere. When you put in a new mattress or new furniture, there can be a lot of formaldehyde," says Dr Hutter.

VOCs emissions are also the biggest environmental issue facing the paint industry too – and you can find more of these compounds in aerosols, adhesives, solvents and cleaning solutions, with the potential to cause eye, nose and throat irritation, headaches and nausea – not to mention damage to the liver, kidney and central nervous system.

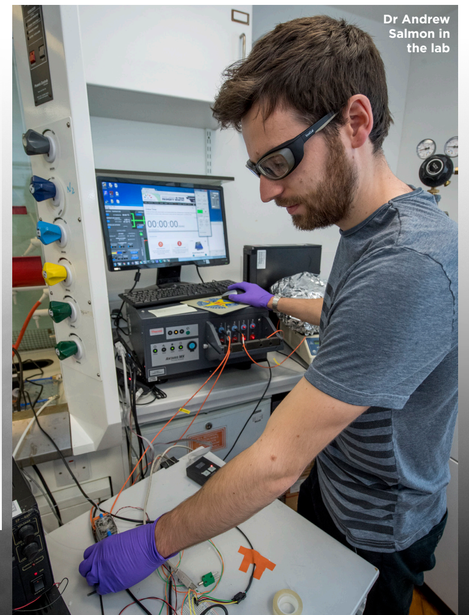


The formaldehyde (CH2O), molecular model, right. Formaldehyde is a known carcinogenic agent and a common indoor air pollutant

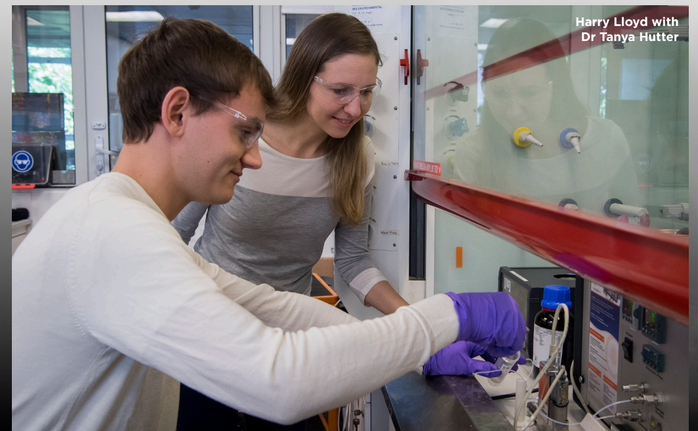
"Formaldehyde, toluene, and other toxic VOCs are emitted from everywhere, but there is no good way of monitoring them at the moment," says Dr Hutter. "There are regulations on many toxic VOCs and more are expected to be introduced. There will be a problem in that how can you report on it if you can't monitor it? So the VOV detection market will grow."

Dr Hutter – who is originally from the Ukraine but grew up in Israel and came to Cambridge for her PhD – hopes SensorHut will release its first product next year. "We are building a small demonstrator with Alphasense and the next step will be to build a product," she says. "Most likely it will be a VOC classifier – one step better as it will give the chemical composition. We are also looking into benzene and formaldehyde sensors because there is an established market. Everyone knows they are toxic and we need to monitor them more so it will be a good start before going into a new market. We also have interest from a company in putting them in a fridge to tell you when your fish or meat is off, so we have a steak in the lab."

She says the experience of building SensorHut has taught her much – and given her a taste for more. "It's exciting because I've got to do things I've never done before, like a starting a company, talking to investors and learning how to pitch, and understanding what business is like," she says. "I am working with very talented people and collaborators to bring this technology to the market. There has been excitement, frustration, hope and despair all together. But I've enjoyed it and, if it goes well, it won't be last my company."



Dr Andrew Salmon in the lab



Harry Lloyd with Dr Tanya Hutter

Eyeing the prize

SensorHut is a finalist in the cleantech category of the *Cambridge Independent* Entrepreneurial Science and Technology Awards, due to be announced on September 21 at Newmarket Racecourse.

Details of all the finalists can be found at *cambridgeindependent.co.uk/business/events-and-awards*.

The company won a prize at the Royal Society of Chemistry's Emerging Technologies Competition in 2016 and Dr Hutter was among five of the UK's most promising female scientists awarded the prestigious L'Oréal-UNESCO for Women in Science Fellowship, UK and Ireland in 2016.