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WHAT'S NEW IN **ELECTRONICS**

DOPPLER EFFECT: **ELECTRONICS IN MOTION**

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CELL DESIGN**

**NEXT-GEN PAINTABLE
SENSORS**

**EXPOSING AIRCRAFT
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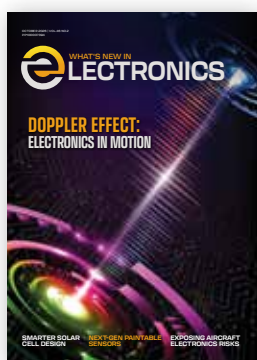
we get technical

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CONTENTS

- 06 THE DOPPLER EFFECT — WHAT IS IT AND HOW IS IT USED IN TECHNOLOGY?
- 12 CONTROLLING DEFECTS HELPS IMPROVE SOLAR CELL PERFORMANCE
- 17 PAINT-ON ELECTRODES ENABLE SMARTER WEARABLE SENSORS
- 21 CYBORG COCKROACHES CARRY ELECTRONICS INTO DISASTER ZONES
- 24 NEUROMORPHIC CHIP COMBINES SENSING, MEMORY AND PROCESSING
- 26 HARDWARE IMPLANT EXPOSES NEW RISK IN AIRCRAFT ELECTRONICS
- 28 NEW METHOD ENHANCES QUANTUM ERROR DETECTION ACCURACY
- 30 PRESSURE SHOWN TO EXTEND EV BATTERY LIFESPAN



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Ashna Mehta
Editor

Cable from the editor

Welcome to the October issue of *What's New in Electronics!*

This month's focus is on componentry, software and embedded devices — three areas that continue to evolve rapidly as electronics become increasingly connected.

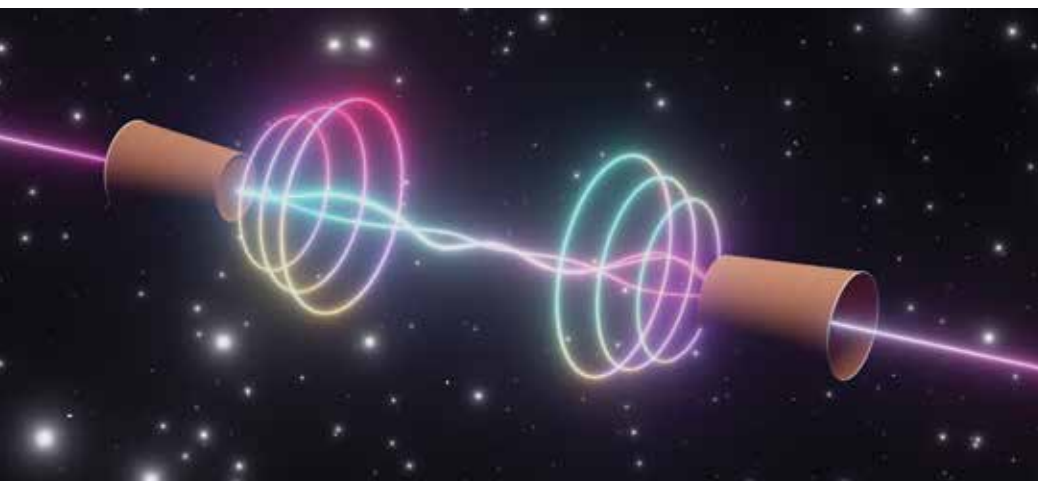
The lead article takes a look at a fundamental phenomenon: the Doppler effect. While the phenomenon was first identified in 1842, its applications are decidedly modern, underpinning technologies ranging from radar and motion sensing to medical imaging and navigation. It's a good example of how established engineering principles can continue to find new relevance as technology advances.

The issue also explores some fascinating research taking place closer to home. Work conducted by UNSW Sydney is investigating how controlling defects at the microscopic level could improve solar-cell performance, highlighting the role that materials engineering and manufacturing precision will play in developing more efficient energy technologies.

Elsewhere, electronics venture into some decidedly unconventional territory, with cyborg cockroaches being explored as potential tools for navigating disaster zones. Meanwhile, at RMIT University, researchers are developing neuromorphic technology that combines sensing, memory and processing on a single chip — an approach that could help reduce energy consumption while enabling more responsive edge devices.

Together, these stories demonstrate how developments in components, software and embedded technologies are helping to reshape what is possible in modern electronic systems.

From fundamental physics to biohybrid systems and brain-inspired computing, there's plenty to explore in this month's issue. I hope you enjoy reading it. If you would like to contribute an article or case study, or have feedback to share, please contact: wnie@wfmedia.com.au.



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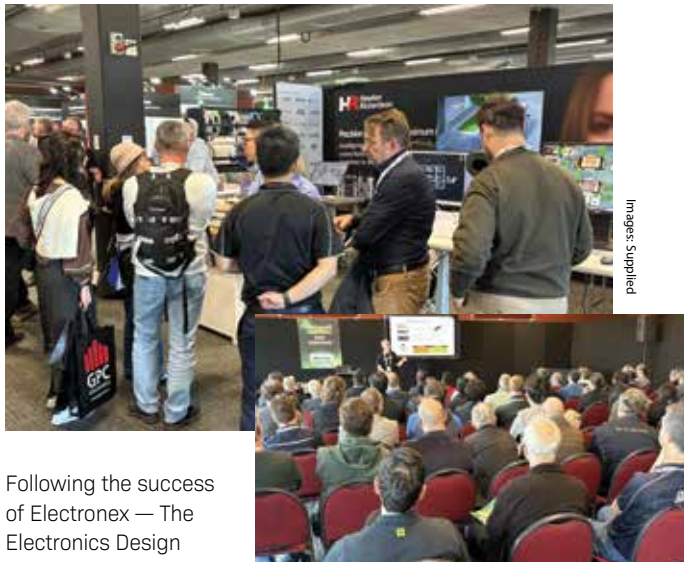
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Electronex 2027 brings electronics industry to Melbourne



Following the success of Electronex — The Electronics Design and Assembly Expo in

Sydney in June 2025, the launch of the 2027 Expo in Melbourne has seen over 70% of the space already booked. The event will be held at the Melbourne Convention and Exhibition Centre from 12–13 May 2027. Now in its 15th year, the Expo and SMCBA conference will again be co-located with Australian Manufacturing Week, which proved to be an outstanding success in 2025 with trade visitors able to visit two major related industry events at the same time.

This year's June Expo was a sell-out, with over 100 companies represented. 350 exhibiting staff had the opportunity to network and discuss business with their peers, with many attending the Exhibitor Networking Function on the Wednesday evening, which was sponsored by *What's New in Electronics* and Dyne Industries.

The Expo was busy across the two days with a steady stream of trade and industry visitors from all states of Australia and New Zealand. The Surface Mount and Circuit Board symposium that was held in conjunction with the Expo had an emphasis on the structural changes needed to strengthen Australia's sovereign electronics manufacturing capability. With a focus on coordination between industry and government, the program explored how policy, investment and innovation could collectively support long-term sector growth.

Noel Gray, Managing Director of organiser AEE, said, "We were delighted with the turnout for the Expo and the floor was buzzing from the time the doors opened. The free seminars that were held on the show floor were also well attended with topics on the application of AI and insights into new technology and future opportunities for electronics manufacturing attracting a full house."

A post-show visitor survey also reinforced the quality of decision-makers who attended, with 78% directly involved in purchasing, specifying or recommending products, while 92% discovered new companies, 88% discovered new products or technology and 98% said a dedicated show such as Electronex was beneficial to their industry. The survey also found that 55% of attendees were first-time visitors, reinforcing the importance of the Expo as a unique sales opportunity to meet new companies and source new business contacts.

Stand bookings are now open for the 2027 Melbourne Expo, which is also expected to sell out. Companies interested in exhibiting can contact the show organiser AEE by email at info@auexhibitions.com.au, or visit the show website www.electronex.com.au.

Photonic chip packaging facility opens in Brisbane

The Queensland Advanced Photonics Packaging Centre (Q-APP) is now open at CSIRO's Queensland Centre for Advanced Technologies (QCAT) in Pullenvale and is the first facility in Australia to prepare tiny photonic chips for real-world technologies.

The next-generation microchips packaged by Q-APP could soon be instrumental in the development of fibre-optic communication and advanced sensing technology, with applications in quantum computing, mining, fire detection and construction.

Photonic chips use light to enhance computing, processing data at super-fast speeds, while being more energy-efficient than standard silicon chips. At Q-APP, the intricate parts that make up a photonic chip will be carefully connected and tested, using specialised equipment under sterile environments.

CSIRO Research Group Leader Karsten Hoehn said the opening of Q-APP will help accelerate the real-world use of promising photonics technologies.

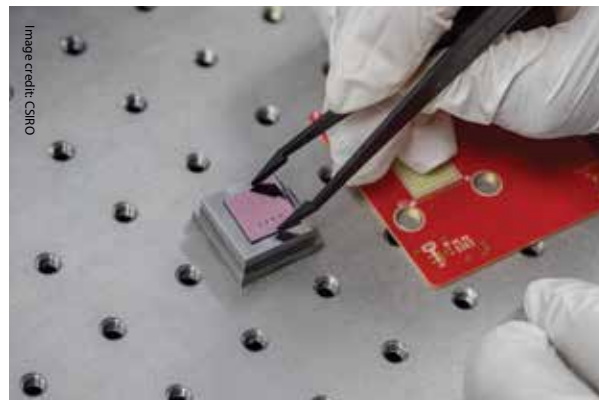
"Q-APP helps bridge the gap between an idea and reality, giving Australian researchers and companies access to the expertise and equipment needed to build and test photonic chips locally. This facility allows us greater mobility and speed in our progress in next-generation computing, bringing developments in faster communications, advanced manufacturing and future quantum systems one step closer than before," Hoehn said.

Prior to the opening of the \$6 million CSIRO facility, photonic chip parts had to be sent overseas for packaging.

Queensland's Chief Scientist Dr Kerrie Wilson said this facility would support Queensland's ambition to grow its quantum and advanced technologies sector and create the workforce it needs to succeed.

"Our science and innovation ecosystem includes researchers working closely with industry partners to develop and scale these technologies, enabling commercialisation of Queensland discoveries and innovations," Wilson said.

Q-APP is primarily funded through the Queensland Government's Quantum and Advanced Technologies Commercialisation Infrastructure Program. The program is designed to help startups and industry accelerate the development and commercialisation of prototype devices, strengthening Queensland's emerging quantum and advanced technology sectors and workforce.

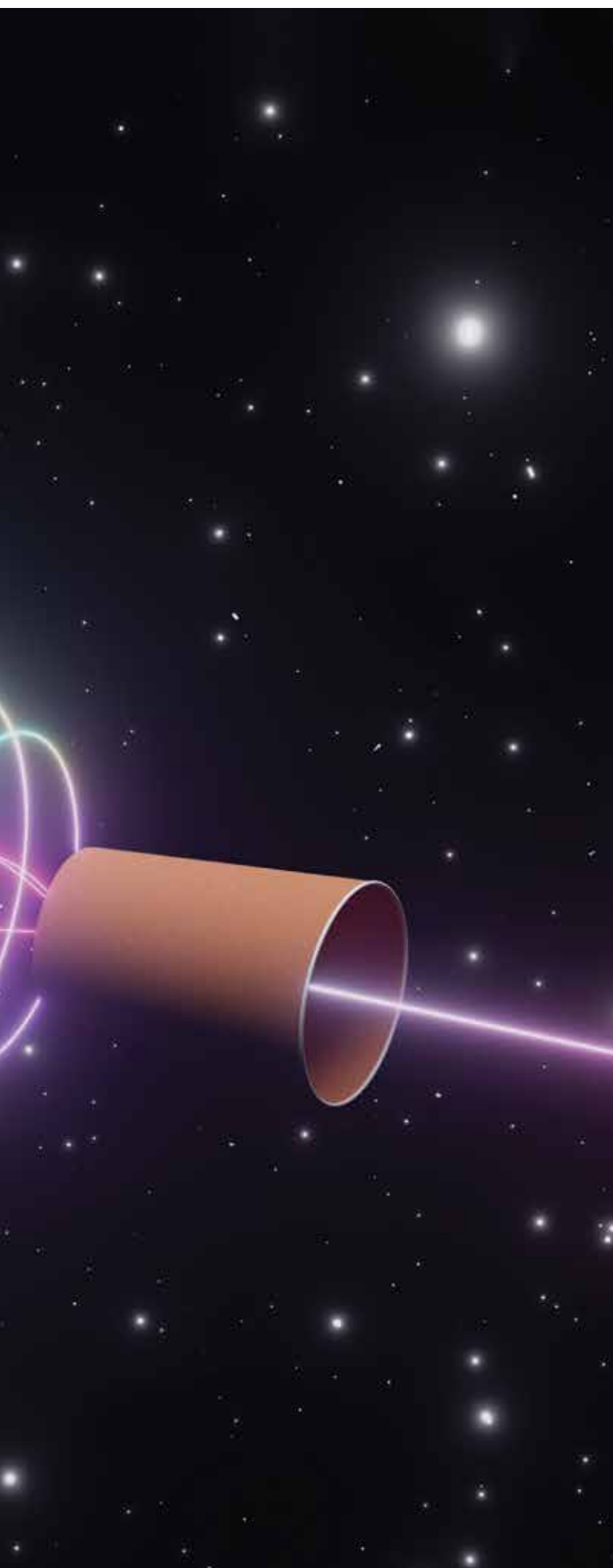


A researcher uses precision tweezers to position a device during laboratory testing and packaging.

The Doppler effect – what is it and how is it used in technology?



THE PHENOMENON KNOWN AS THE DOPPLER EFFECT IS ONE OF THE FUNDAMENTAL MECHANISMS USED IN MODERN PHYSICS AND ENGINEERING. ALTHOUGH IT IS MOST COMMONLY ASSOCIATED WITH THE CHANGE IN PITCH OF A PASSING AMBULANCE SIREN, ITS SIGNIFICANCE EXTENDS FAR BEYOND ACOUSTICS. THIS EFFECT IS APPLIED IN SATELLITE NAVIGATION SYSTEMS, MEDICAL DIAGNOSTICS, AND RADARS USED IN TECHNOLOGY AND METEOROLOGY.



The phenomenon was described in 1842 by Austrian physicist Christian Doppler and has since become one of the key tools for analysing motion and wave propagation. This article explains what the Doppler effect is and how it is used in technical practice.

What is the Doppler effect?

The Doppler effect involves a change in the frequency of a wave perceived by an observer when the wave source and the observer are moving relative to each other. It is this relative motion that causes the change in perceived wave parameters — whether we are talking about sound, light or radio waves.

The most intuitive example involves acoustic waves. When an emergency vehicle with a siren approaches us, we hear a higher-pitched sound. As it passes by and starts moving away, the pitch suddenly drops. This is not due to a change in the siren's operation but rather the properties of wave propagation in motion.

The mechanism of this phenomenon can be easily understood by analysing the way waves propagate. In the case of a stationary source, wave fronts spread evenly in all directions. However, if the source moves towards the observer, successive waves are emitted from increasingly closer positions, leading to their 'compression' — the wavelength decreases and the frequency increases.

Similarly, behind a moving source, waves undergo 'stretching', resulting in a decrease in the frequency perceived by the observer. In the case of mechanical waves (eg, sound), this relationship can be described using the formula:

$$F_o = f_s((v \pm v_o)/(v \mp v_s))$$

where:

- f_o — received frequency
- f_s — source frequency
- v — wave speed in the medium
- v_o — observer speed
- v_s — source speed.

The choice of signs depends on the direction of motion — when the source approaches, the frequency increases, and when it moves away, it decreases.

Does the Doppler effect only work for sound?

Many people associate this phenomenon solely with acoustic waves (sound), but in reality, it has a universal nature. The Doppler effect occurs for any wave, including electromagnetic waves such as visible light, microwaves, or radio waves used in radar technology.

Although the general principle of operation remains similar, there is a significant difference in how this phenomenon occurs and how it is described for different types of waves.

Mechanical waves (eg, sound)

Require a physical material medium, such as air or water, to propagate. In this case, the change in observed frequency depends on the motion of the source and observer relative to the medium itself.

Electromagnetic waves (eg, light and radar)

Have a different nature — they do not require a material carrier and can propagate in a vacuum. Moreover, according to the principles of the special theory of relativity, the speed of light is constant for every observer, regardless of their motion. Therefore, the classical description of the Doppler effect is insufficient, and relativistic phenomena, particularly time dilation, must be considered.

The relativistic description of the Doppler effect leads to interesting consequences. One of them is the so-called **transverse Doppler effect**, where a frequency change occurs even when the source moves perpendicular to the line of observation. This phenomenon directly confirms the influence of time dilation.

Practical applications of the Doppler effect

From abstract theory to everyday practice — the Doppler effect has become one of the foundations of many fields of technology and science. This phenomenon finds wide application in the following areas:

Doppler radar

The principle of this technology is based on emitting a signal of known, stable frequency, which, after reflecting off a moving object, returns to the receiver with changed characteristics. The system analyses the so-called 'beat tone' (the difference between the transmitted and received wave), allowing for quick and precise determination of the target's speed. This solution is used in police speed measurements and meteorology. Doppler radars enable the analysis of air mass movements within clouds, allowing for the detection of phenomena such as mesocyclones and early signs of tornadoes.

Measurement of liquid and gas flow

In industry, the Doppler effect is used for non-invasive flow measurement. Doppler flow meters analyse the frequency change of ultrasonic waves reflecting off solid particles or gas bubbles carried by the medium. This makes them well-suited for measuring difficult liquids, such as sewage, suspensions or aerated water.

Motion sensors (PIR and microwave)

In alarm systems and smart home installations, alongside infrared sensors (PIR), active microwave sensors are used. They emit electromagnetic waves and analyse the returning Doppler echo. Their significant advantage is the ability to penetrate materials such as glass or thin walls, allowing for concealed installation — in suspended ceilings or installation enclosures.

Medicine

Doppler ultrasonography is one of the basic diagnostic tools in cardiology and angiology. In this examination, red blood cells act as moving objects, and frequency shift analysis allows for determining blood flow velocity. This method enables early detection of valve defects, thrombosis, aneurysms and monitoring heart and fetal circulation.

Communication technologies (GPS/GNSS)

The Doppler effect plays a significant role in satellite navigation systems. Satellites move at very high speeds, causing frequency shifts in received signals. GPS receivers use this phenomenon for faster synchronisation with satellites and determining user speed — often with very high accuracy.

What are the limitations and challenges?

Despite its versatility, using the Doppler effect in practice involves certain technical and physical limitations. When designing



The Doppler effect has evolved from a theoretical consideration to one of the key tools of modern technology and science.

measurement devices, engineers must consider several key factors affecting the accuracy and reliability of results.

Cosine error (measurement angle influence)

This is one of the most frequently discussed limitations, especially in the context of road radars. It occurs when the measuring device is not exactly on the line of the object's motion but at a certain angle. In such a situation, the radar measures only the radial component of speed, leading to an underestimated result. The recorded speed is equal to the actual speed multiplied by the cosine of the measurement angle, whose value is always less than one.

Environmental conditions and multipath propagation

Measurement accuracy depends significantly on the environment in which the wave propagates. In densely built-up areas, the signal undergoes multiple reflections from obstacles, leading to so-called multipath propagation. As a result, the receiver may register multiple signals with different Doppler shifts, making correct interpretation difficult. Additionally, measurement effectiveness may depend on the medium's properties — for example, Doppler flow meters require the presence of particles or bubbles for the wave to reflect.

Signal filtering and compensation necessity

Raw Doppler signals are rarely suitable for direct use. In precise systems like GNSS/GPS satellite navigation, computers must account for extremely complex corrections. These include adjustments resulting from general and special relativity (clocks on satellites tick at different speeds from on Earth) and the so-called Sagnac effect, introduced by our planet's rotational motion. In simpler electronic systems, the challenge is signal processing quality — filtering algorithms are necessary to reject interference, such as noise from the electrical grid (50/60 Hz) or fluorescent light flicker (100/120 Hz).

Can it be used in amateur projects?

Absolutely. The Doppler effect is not reserved exclusively for advanced laboratories or expensive radar systems. Thanks to the availability of affordable microwave modules, such as the popular HB100 module (operating in the 10.525 GHz band),

it is possible to independently build motion detection and speed measurement systems.

The HB100 module is essentially a simple, bi-static Doppler radar consisting of a microwave generator (dielectric resonator oscillator, DRO) and a mixer that compares the transmitted signal with the signal reflected from a moving object.

However, to use it correctly in a project (eg, based on Arduino), several important aspects must be considered:

Signal amplification

The module's output signal has a very low amplitude (on the order of microvolts), so an external amplifier is necessary. In practice, operational amplifiers (eg, LM358 or TL072) are used, providing amplification at the level of tens of thousands of times.

Signal filtering

To detect slow movements (eg, a person moving at a speed of 1–2 m/s), it is necessary to limit the signal bandwidth and filter out higher frequencies. This eliminates interference from sources such as the power grid (50/60 Hz) and lighting (100/120 Hz).

Digital processing

A modern approach involves sampling the signal with a microcontroller's ADC and analysing the frequency spectrum. In practice, the FFT (Fast Fourier Transform) algorithm is used to extract the dominant frequency component and associate it with the object's speed.

With this approach, it is possible to build functional systems — such as intelligent motion sensors, automatic lighting or simple alarm systems. Importantly, unlike PIR sensors, microwave solutions can detect motion even through obstacles like thin walls or doors.

Summary

Since its presentation in 1842, the Doppler effect has evolved from a theoretical consideration to one of the key tools of modern technology and science. Its universality stems from the fact that it relates to fundamental phenomena associated with motion and wave propagation — both mechanical and electromagnetic.

Today, it finds applications in many areas: from medical diagnostics, through radar systems and industrial measurements, to satellite navigation. In each of these cases, it allows for precise determination of speed, direction of motion or flow parameters.

Whether we are talking about studying blood flow, controlling vehicle speed or analysing satellite signals, the principle of operation remains the same. It is this simplicity and immense usefulness that make the Doppler effect one of the foundations of modern engineering.

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Could urea be used to create electric vehicle batteries?



Researchers from Adelaide University's School of Chemical Engineering have identified a new way to create an important chemical in energy storage by using urea.

Hydrazine, the chemical in question, is widely used in a variety of industries including pharmaceuticals and rocket fuels, as well as emerging energy systems and electric vehicle batteries.

"Hydrazine is industrially synthesised from ammonia or a derivative urea created through an established method," said Dr Pengtang Wang.

"These methods have been developed and employed for decades, but they rely on other hazardous chemicals, and use a great deal of energy, which makes it costly and environmentally challenging. Developing a new and mild alternative to this conventional process would represent an important step towards greener and more economical hydrazine production," Wang said.

The research team created an electrochemical strategy which converted urea into hydrazine using electricity and sodium chloride, with findings published in the journal *Nature Synthesis*.

"Urea was chosen as the feedstock because it is abundant in human urine," Wang said.

"Turning this readily available resource into hydrazine could provide a potential pathway for fuel production, including applications in fuel cells and long-duration space missions. Sodium chloride helps drive the reaction by generating adsorbed chlorine species on the electrode surface. These chlorine species react with urea to form N-chlorourea, which is then converted into hydrazine through a simple hydrolysis process," Wang said.

Using this strategy, the researchers achieved high-yield hydrazine production and demonstrated its versatility across different urea sources, including pure urea, urea-rich wastewater and human urine.

"Although this electrochemical strategy enables efficient urea-to-hydrazine conversion, practical engineering challenges and associated cost bottlenecks, including salt accumulation and energy consumption required for product isolation, remain to be addressed," Wang said.

"Future research will focus on reducing costs, simplifying product separation, improving continuous system operation and developing more practical reactor designs. With these engineering advances, we believe this technology could provide a sustainable alternative route for hydrazine manufacturing powered by renewable electricity," Wang said.

3D-printed battery component enables custom cell designs

A team of researchers at The University of Texas at El Paso has developed a way to 3D-print an essential battery component in nearly any shape. Their innovation could free engineers from the constraints of standard rechargeable battery sizes and allow energy storage to be built directly into the devices the batteries power.

The work, detailed in a study published in *Communications Engineering*, is about gel polymer electrolytes, the material inside a battery that carries the ions (the particles which carry the electrical charge) between the electrodes (the two terminals where chemical reactions occur and electricity enters or leaves the battery).

Conventional electrolytes are liquids that must be sealed inside rigid casings, a design that limits battery shapes and raises safety concerns about leaks. The UTEP team created a printable gel by combining a light-curable resin with a lithium-based liquid electrolyte, then hardened it layer by layer using a technique called vat photopolymerisation.

The printed material performed on par with electrolytes made by conventional methods, reaching ionic conductivities of up to 3.4×10^{-3} siemens per centimetre, close to the performance of the liquid electrolytes it could replace. The researchers also pinpointed an optimal recipe, a one-to-four ratio of resin to electrolyte, that balanced strong electrochemical performance with clean, reliable printing.

Just as important for real-world use, the team printed the electrolytes in ordinary laboratory air rather than inside a sealed, oxygen-free chamber, and the material kept its performance. To demonstrate the design freedom the method offers, the researchers printed simple discs, an open honeycomb lattice and a solid one-centimetre cube, illustrating how future batteries could be shaped to fit a wearable, a medical device or an aerospace part rather than forcing the device to accommodate the battery.

"For years, the shape of a battery has dictated the shape of the device it powers," said Alexis Maurel, PhD, the study's lead researcher. "We are showing that you can print a high-performing electrolyte battery component with any shape and place it almost anywhere you want. That changes what designers are able to imagine."

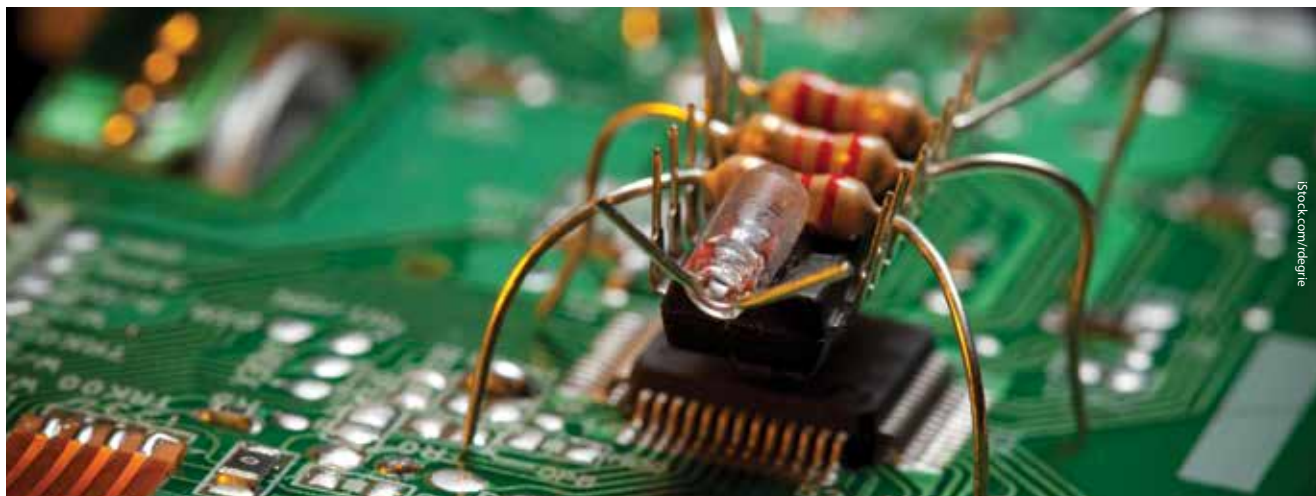
The work also clarified how the choice of solvent shapes both printability and battery behaviour, a question the authors note had gone largely unexamined in earlier research on printable electrolytes. One formulation proved especially stable during repeated testing, helping the team identify the most promising path forward.

The research was led by UTEP scientists in collaboration with Sandia National Laboratories. The team plans to refine its formulations and work towards incorporating these printed electrolytes into complete battery cells.



Image credit: The University of Texas at El Paso

Semiconductor chips enable biomolecular sensing



Bioengineers at the University of California San Diego have integrated the olfactory receptor of an insect called a jumping bristletail into semiconductor chips made of graphene, creating an electronic nose capable of sniffing out a variety of small organic compounds.

This biomimetic bioelectronic sensor can detect and distinguish between molecules that are difficult for conventional electronic sensors to differentiate. This work opens the door to building semiconductor-based chemical sensing systems inspired by nature for applications in health care, environmental monitoring, food quality, agriculture and biodefence.

In a paper published in *Advanced Materials*, researchers led by bioengineers at UC San Diego describe a method to manufacture at scale the MhOR5 odorant receptor from the insect *Machilis hrabei*, and chemically attach the purified MhOR5 protein to high-performance graphene field effect transistors (gFETs). gFETs are semiconductor devices that rely on graphene instead of silicon as the conductive material, resulting in exceptional sensitivity to molecular change.

The researchers tested their MhOR5-functionalised gFETs against 16 chemically diverse compounds, including DEET, hexanol and eugenol, at different concentrations. The sensor produced a concentration-dependent electrical response for each of the 16 compounds.

"Advances in engineering, biology, biomanufacturing and semiconductor technology are now making it possible to reproduce the remarkable sensing capabilities of other organisms, and directly interface them with scalable semiconductor chips," said Kiana Aran, corresponding author of the study. "We're no longer just studying biology; we're beginning to integrate biological functions with semiconductor technology in a way that can be manufactured at scale."

To manufacture, purify and integrate MhOR5 into the gFET, the researchers took the genetic sequence of this olfactory receptor, synthesised it and transfected this receptor into mammalian cells. They purified the MhOR5 protein from cell membranes, and found that the MhOR5 protein's tetrameric form was stable after being stored for three months at -80°C. The manufactured MhOR5 was also stable after being subjected to several freeze-thaw cycles.

The researchers then took the purified MhOR5 protein and chemically attached it to the graphene surface of the gFET platform using Carbodiimide Crosslinker Chemistry and the PBASE molecule that links molecules including proteins with carbon-based nanomaterials such as graphene.

This is reportedly the first direct integration of MhOR5 onto a gFET for selective, label-free detection of small organic compounds.



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Controlling defects helps improve solar cell performance

Neil Martin, UNSW

UNSW ENGINEERS HAVE HARNESSSED THE FUNDAMENTAL SKILLS OF BAKERS TO ENSURE NEXT-GENERATION ENVIRONMENTALLY FRIENDLY SOLAR-CELL MATERIALS FORM WITH FEWER TINY DEFECTS.

The discovery allows the cells to convert sunlight into electricity more efficiently than before and could provide a blueprint for improving a wide range of advanced semiconductor materials.

The trick is to imagine baking a cake.

Although every ingredient is carefully measured and mixed together, sometimes as the cake bakes the butter can pool in one corner, the cinnamon is stronger in one section, and the fruit sinks to the bottom.

So even though the ingredients were all correct and the recipe was followed, the final cake is far from perfect.

According to researchers from UNSW, something remarkably similar happens when manufacturing one of the world's most promising solar cell materials.

"The cake analogy is really apt because that's exactly what we are doing," said

Scientia Professor Xiaojing Hao, from UNSW's School of Photovoltaic and Renewable Energy Engineering.

"With a cake you mix all the different ingredients and put it into the oven. We do a similar thing with solar cell material, except it goes into a furnace."

In research published in *Nature Energy*, Hao and colleagues have shown that it isn't simply the ingredients that matter — it is keeping them evenly distributed throughout the earliest stages of manufacturing.

By preventing those ingredients from drifting apart, the team dramatically reduced tiny defects inside the material that limit how efficiently it converts sunlight into electricity.

The findings establish a new design principle that could not only improve this particular solar technology, but also influence the development of many other advanced semiconductor materials.

Looking beyond silicon

Most of today's solar panels are made from silicon, a technology that has become remarkably efficient over decades of development. But researchers around the world are already searching for ways to push solar performance even further.

One of the most promising approaches is the tandem solar cell, which combines two different semiconductor materials so each captures different parts of the solar spectrum.

Hao's team, including Dr Ao Wang and Dr Kaiwen Sun, is studying a material known as CZTS made from copper, zinc, tin and sulfur.

Unlike some competing semiconductor materials, its ingredients are abundant and comparatively environmentally friendly, making it an attractive candidate for future tandem solar cells.

The challenge has been that, despite its promise, CZTS has stubbornly resisted attempts to reach the efficiencies needed for commercial adoption.

The culprit is tiny defects that form as the material is manufactured.



Scientia Professor Xiaojing Hao working in UNSW's School of Photovoltaic and Renewable Energy Engineering.

the formation of unwanted impurities and tiny structural defects that prevented the material from performing at its best.

The UNSW team then found that strengthening the copper-sulfur bonding during the initial thermal reaction significantly reduced defect formation and enabled the material to achieve record voltage performance for this class of CZTS solar cell.

Eliminating hidden flaws

Although the defects in CZTS are incredibly small, many no larger than individual atoms, their impact on solar-cell performance is enormous.

"When one ingredient drifts away, it forms another phase, which is technically another material. So when the crystal grows, you end up with impurities and tiny imperfections inside it," Hao said.

"It also causes disorder inside the crystal. Those point defects can trap the photo-generated carriers, and that causes the low efficiency of solar cells.

"Voltage is a direct measure of the energy loss inside the solar cells. Every detrimental defect reduces the voltage. Defect control determines the final efficiency and how much energy can be converted from sunlight."

Using their new manufacturing strategy, the team achieved a certified efficiency of 12.4%.

While that efficiency remains below commercial silicon solar cells, researchers say the result is significant because it addresses one of the technology's longest-standing scientific challenges.

A solution for other materials

The researchers believe the most important outcome is not simply a better CZTS solar cell.

Instead, they say the work establishes a broader design strategy that could help improve many different semiconductor materials used in future solar technologies.

Co-author Dr Ao Wang says researchers have often assumed that if the starting ingredients are correct, the heating process will naturally produce the desired material.

"Most people focus on getting the right recipe and think the thermal process is a black box. They assume that once the ingredients are mixed well then the cake, or in this case the solar cell, will naturally come out as intended. But this is not the case. If the butter starts separating in the first few minutes of baking, even a perfect recipe won't produce a perfect cake," Wang said.

That seemingly simple idea could have implications well beyond CZTS.

Many advanced semiconductor materials consist of several different chemical elements, making them susceptible to similar problems during manufacturing.

Hao believes understanding, and then controlling, how those ingredients behave during the earliest stages of fabrication could become an important design principle across the field.

"The defect control strategy we've developed is going to be really useful for designing and optimising other compound semiconductors," Hao said.

"I hope our defect control technology and principle can really be used by other people who are designing more top-cell candidates for tandem solar cells.

"The design principle isn't only about this material. It's about not only looking at the final recipe, we need to design from when we're mixing the ingredients and keep them uniformly distributed. The ingredients may change from one semiconductor to another, but the design principle is the same."

Hao said many researchers have traditionally focused on ensuring they started with the correct combination of ingredients.

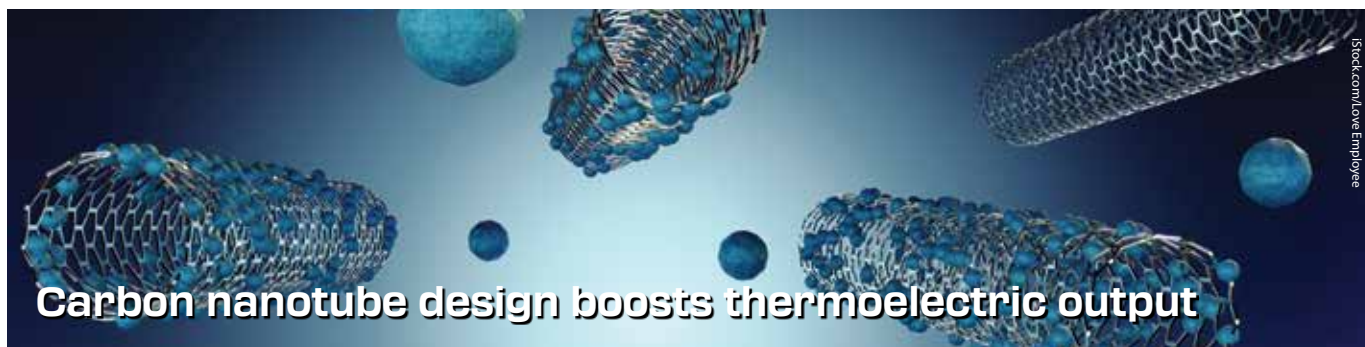
"A lot of people think once you have the right amount of ingredients for the cake, then everything will be fine," Hao said.

"But sometimes that's not the case. You need to keep the ingredients uniformly distributed from the very beginning and throughout the cooking process.

"The journey matters just as much as the destination. That's the major design principle we've implemented in this research to discover why CZTS can have the imperfections."

Rather than concentrating on whether the ingredients of the solar cell material were wrong and needed to be amended, the team investigated what happens during the first moments of the high-temperature manufacturing process.

They discovered that one element in particular, the copper, was prone to moving away from where it was needed. That seemingly small change triggered



Carbon nanotube design boosts thermoelectric output

Researchers from the Queensland University of Technology (QUT) have overcome a challenge that could open the door to more powerful wearable electronics and new ways to turn wasted heat into electricity. The researchers have developed a new molecular strategy that prevents carbon nanotubes — flexible and conductive microscopic rods that have shown promise for wearable technologies but can be difficult to control — from clumping together and losing performance.

The research findings have provided a new benchmark for materials that convert heat directly into electricity. Lead author and QUT PhD researcher Shanshan Zhou said the work established a new way of tackling one of the biggest challenges facing carbon nanotubes.

“Instead of trying to improve existing approaches, we came up with a new way to stop carbon nanotubes sticking together, which has been a major challenge for researchers for years. Because the approach is so flexible, it could be used to create a new generation of higher-performing materials for harvesting energy from heat,” Zhou said.

Professor Zhi-Gang Chen, Director of the ARC Research Hub in Zero-Emission Power Generation for Carbon Neutrality, said carbon nanotubes had enormous potential, but one persistent problem had stood in the way.

“For many years, researchers have recognised that carbon nanotubes are excellent candidates for wearable thermoelectric devices because they are lightweight, flexible and electrically conductive. However, their tendency to aggregate has severely limited their performance. Our new molecular design fundamentally changes how carbon nanotubes interact with each other. Instead of allowing them to clump together, we use specially designed molecules to keep the nanotubes apart without affecting their ability to carry electricity,” Chen said.

The researchers demonstrated the material’s real-world promise in a flexible device that generated electricity from body heat and remained durable after extensive bending and folding tests. Chen said the technology could eventually enable battery-free wearable devices.

“Imagine health monitoring sensors, smart textiles or wearable electronics that continuously harvest energy from your own body heat instead of relying on conventional batteries,” Chen said.

The researchers believe the technology could also be applied to waste heat recovery, flexible sensors, the Internet of Things and next-generation sustainable electronics.

The research findings have been published in *Angewandte Chemie International Edition*.

Novel silicon carbide transistors operate at 600°C



Researchers at Kyoto University have developed a new silicon carbide (SiC) junction field-effect transistor (JFET) structure that demonstrates reliable operation at temperatures up to 600°C. Previous research has suggested that complementary JFETs, based on SiC JFETs, can be applied to low-power integrated circuits for operation in extreme environments. However, the JFETs previously developed by researchers — which featured conventional top-gate structures fabricated in semi-insulating SiC substrates — suffered from low controllability and large leakage currents at high temperatures.

The new device uses a bottom-gate architecture to improve the threshold-voltage controllability and a well-based isolation structure to suppress leakage current at high temperatures, thereby addressing the limitations of earlier SiC JFET designs.

“Our goal is to open a new path forward with complementary JFETs designed to harness the intrinsic properties of SiC itself,” said Mitsuaki Kaneko, first author of the research findings published in *APL Electronic Devices*.

Rather than developing everything from scratch, the team deliberately employed industry-standard manufacturing methods to build their new JFET structure. They also employed well-based isolation instead of a semi-insulating substrate to suppress the high-temperature leakage current.

The result was a new SiC transistor structure that succeeded on the very first attempt. Upon completion of the new design, the team was able to demonstrate that their device can operate successfully at 600°C. The adoption of the bottom-gate structure improved the transistor’s threshold voltage controllability and reduced the leakage current, which is now very close to the theoretical limit predicted from the material properties of SiC.

This study proves that SiC is already a mature power device technology in itself and demonstrates the immense potential of the newly developed bottom-gate structure for implementing reliable, extreme-temperature SiC-based integrated circuits.

However, many challenges still lie ahead on the path to practical implementation. One by one, the team intends to address these by creating more complex circuits, scaling up to wafer-level production and ensuring the entire package remains robust in extreme environments.

Light triggers novel ferroelectric switching mechanism

Researchers at Flinders University have discovered an unexpected way that light can control tiny electronic structures inside advanced materials, a development that could help pave the way for more energy efficient memory devices, sensors and future computing technologies.

The new study seeks inroads into electronic properties and optical science by exploring new energy and material capabilities.

"We discovered that light can control nanoscale 'bubble' domains (about the size of just a few billionths of a metre across) inside a special ferroelectric crystal," said Dr Pankaj Sharma, Senior Lecturer in Experimental Condensed Matter Physics at Flinders University.

"However, while most materials respond while the light is shining on them, what surprised us was that the biggest change happened after the light was switched off. By engineering these nanoscale structures, we may be able to develop faster and more efficient electronic and optoelectronic technologies," Sharma said.

The study was led by Dr Haoze Zhang, a Postdoctoral Fellow in the Sharma research group at Flinders University's College of Science and Engineering.



While the nano-domains only responded in a minor way when illuminated with near-visible light, they rapidly expanded the moment the light was switched off. This temporarily switched the electronic state of the crystal's surface the nano-domains gradually returned to their original configuration.

"This behaviour reveals a completely new way that light and electronic structures

interact inside ferroelectric materials," Zhang said.

Using advanced microscopy and electrical measurements, the Flinders researchers with collaborators from UNSW Sydney, India and the US tracked how electrical charges move through the material during and after illumination.

They found that electrons accumulate near the surface while the light is on and are suddenly released when the light is removed, triggering the rapid switching process.

"Because the switching occurs after the light is removed, the approach could reduce energy consumption and minimise unwanted heating compared with conventional light-controlled devices," Zhang said.



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Edge computing system

Backplane Systems Technology has introduced the IBASE AGS104L, an ultra-compact IoT gateway and edge computing system created for connected industrial applications. Designed for space-constrained environments, the edge computing system provides a fanless computing platform for industrial automation, remote monitoring and distributed edge deployments.

Its compact form factor makes it easy to integrate into cabinets, equipment enclosures and field installations where space is limited but connectivity remains essential. The edge computing system is suitable for applications that need local data handling and dependable industrial operation, helping bridge machines, sensors and communications infrastructure at the edge.

The platform is especially relevant to industrial IoT projects, transportation systems and automation architectures where a small but capable gateway device is required. By combining compact design, industrial reliability and edge-ready functionality, it provides a practical solution for organisations deploying intelligent connected systems.

For integrators building modern edge architectures, the IBASE AGS104L offers a useful platform for linking equipment, processing local data and supporting industrial connectivity in a small footprint.

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Flow rate transmitter

The HYDAC EVS 3108-H electronic flow rate transmitter is a high-performance flow monitoring solution designed to measure hydraulic oil flow in mobile and industrial applications. Operating on the proven turbine principle, the HIS-sensor measures the rotational speed of an impeller within the fluid and converts it into a precise electronic signal for flow measurement.

Equipped with HYDAC Sensor Interface (HSI) technology, the flow rate transmitter is automatically recognised by compatible HYDAC measuring instruments, including the HMG 500, HMG 510, HMG 3000, HMG 3010 and CMU 1000. This enables automatic sensor identification, power supply and transfer of measuring range, measured values and engineering units, reducing setup time and minimising the risk of configuration errors.

Designed for demanding hydraulic systems, the flow rate transmitter supports fluids with viscosities from 1 to 100 cSt and offers optional connections for pressure and temperature transmitters, allowing multiple process variables to be monitored from a single installation point. With its robust construction and seamless integration with HYDAC diagnostic equipment, the EVS 3108-H provides an efficient solution for hydraulic system monitoring, commissioning and maintenance.

HYDAC INTERNATIONAL
www.hydac.com.au

GNSS/Inertial navigation system

The VectorNav VN-310E is a compact, tactical-grade dual GNSS/inertial navigation system (GNSS/INS) designed for applications requiring precise navigation, positioning and orientation in demanding environments. Integrating two multi-band GNSS receivers, precision MEMS inertial sensors and advanced onboard sensor fusion, the system is designed to deliver position, velocity and attitude information for autonomous and mission-critical systems.

Dual-antenna GNSS technology enables true heading while stationary, eliminating the need for vehicle movement to establish heading. The integrated inertial navigation system helps maintain navigation performance during brief GNSS interruptions, making the VN-310E suitable for challenging operating conditions.

Measuring 31 x 31 x 12 mm, weighing 15 g and consuming less than 1.6 W, the inertial navigation system is designed for a range of space-constrained platforms. Navigation outputs are available at rates up to 400 Hz, with raw IMU data up to 800 Hz, enabling responsive control for high-dynamic applications.

Suitable for UAVs, UGVs, marine systems, robotics, defence platforms and other autonomous vehicles, the VectorNav VN-310E is available in Australia and New Zealand through Metromatics, the authorised distributor for VectorNav.

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Paint-on electrodes enable smarter wearable sensors

Ty Tkacik, Penn State University

ENGINEERS AT PENN STATE ARE BLENDING ART AND SCIENCE TO CREATE CUTE, PAINT-ON TATTOOS THAT COULD HELP SPOT HEART ATTACKS EARLY, POWER ROBOTIC PROSTHETICS AND READ BRAIN WAVES — ALL WITHIN A COLOURFUL, CUSTOMISABLE SYSTEM THAT CAN BE EASILY WASHED AWAY OR REAPPLIED.

The team has designed and filed a provisional patent for a conductive ink that can power sensors and be painted directly onto a person's skin in whatever design they can imagine. The ink, which can be pigmented with any desired colour, uses materials that better bond with the skin, meaning they're not just stylish, but more sensitive, durable and accurate than other wearable sensor designs. The team detailed their work in a paper published in the *Proceedings of the National Academy of Sciences*.

Wearable healthcare technologies are powered by electrode contacts attached to the body, said Larry Cheng, James L. Henderson Jr. Memorial Professor of Engineering Science and Mechanics at

Penn State and corresponding author on the paper. The electrodes can interpret the health and activity of a patient's heart, muscles and brain by recording different electrical signals produced by the body.

Traditional electrode designs use rigid, metal-based materials that offer stability, but struggle to stay attached to the body during movement or exercise. Many experimental designs, like the ones Cheng has been researching for over a decade, use a soft, jelly-like material known as hydrogel, which can absorb and swell with water to stretch and better match the body's movement. However, this material can dehydrate over time, causing the electrodes to lose adhesion and stretchiness with prolonged use.

Wanqing Zhang, an engineering science and mechanics doctoral candidate and first author on the paper, said that it's not just the electrodes peeling off that contributes to less accurate sensor readings, but the actual act of applying them. Many commercial sensors have trouble accurately recording what is happening inside a patient's body, especially when applied to hairy or sweaty skin.

"Most commercial electrodes are prefabricated in a lab or factory and then layered on the skin, meaning there is an air gap between the skin and the electrode, which negatively impacts sensing performance," Zhang said. "To address this, we've developed conductive ink that can be painted directly to the skin. After drying, it acts as a functional electrode." >



In addition to being customisable, the team reported that sensors powered by their electrodes are extremely responsive.

Don't wear a boring patch – grab a brush and paint your own

The team mixed several different types of polymers, or plastics, and acidic additives into a water-based solution to create the ink. It has the consistency of glue when wet but can dry onto the skin in less than 10 minutes, Zhang said. Drying can be accelerated with the help of a hair dryer.

"The ink itself almost behaves like face paint," Cheng said. "It starts out almost transparent, but you can use food dye to pigment the ink into whatever colours you need to paint whatever design you have in mind — like a cartoon or Superman. This allows us to personalise the wearable to a person's preference."

In addition to being customisable, the team reported that sensors powered by their electrodes are extremely responsive. Zhang explained that painting the material directly onto the skin allows it to better conform to the skin's texture, in turn, improving measurements.

To enhance the stability between the electrodes and the sensors they inform,

a connective region of the electrodes is painted onto a porous, silver textile — almost like a metal fabric — placed on the skin. The wet ink flows into the textile before hardening and sticking to the skin's surface. The connective portion is then clipped into a port on the larger electric module, which is taped on the wearer's skin underneath their clothes. This larger module transmits the electrical signals collected by the ink wirelessly to a computer using Bluetooth.

The textile's porous structure allows the electrodes to stretch to over 150% their original size without breaking, while more uniformly adhering to the skin's texture and effectively recording electrical signals.

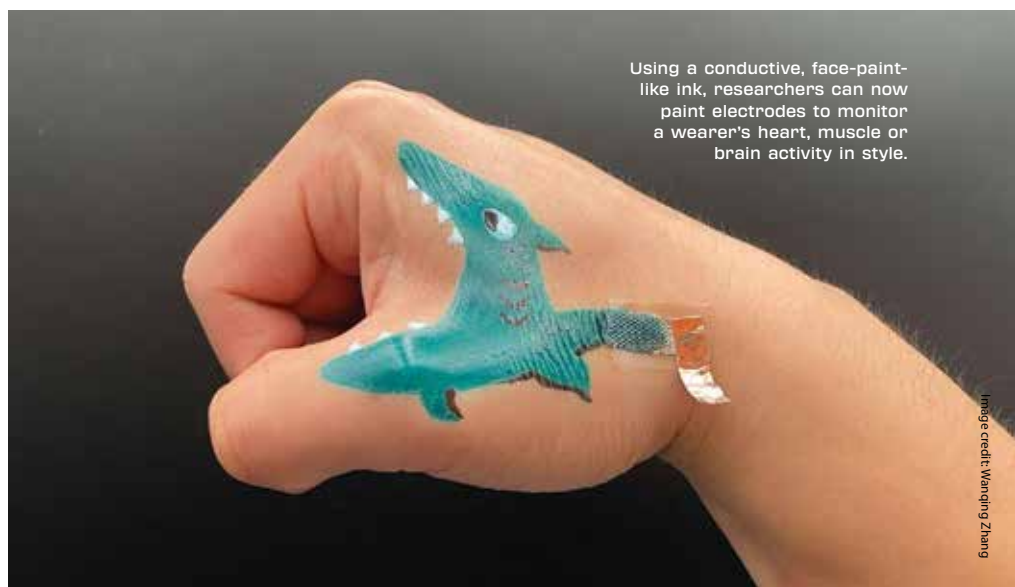
"Over multiple days with other materials, sweat and moisture will accumulate on the electrode interface, potentially causing

irritation or disconnection from the skin," Cheng said. "By using a porous structure, we can allow moisture or hair to better pass through the material, making the electrodes more conductive, adhesive and comfortable."

In one experiment, the team showed that the painted electrodes could effectively track the ECG readings of a co-author during their daily activities over the course of 12 hours, while in another test, a separate co-author tracked their readings throughout an exercise routine, proving that the electrodes maintain adhesion and accuracy even during physical activity. In another test, the team tracked EMG signals of a co-author's forearm and fed them to a robotic prosthetic, enabling the individual to control the robotic hand without touching it.

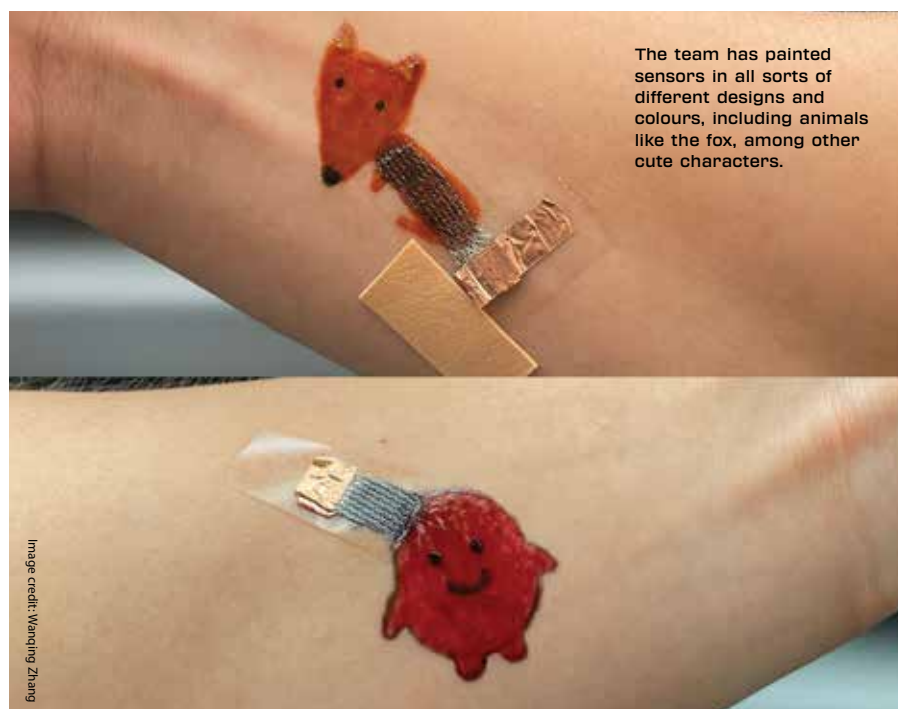
"Although we tested the daily use application over a 12-hour period, this is not the limit for these electrodes," Cheng said. "The electrodes themselves can be washed away and easily reapplied. The big idea behind this is that in the future, you could potentially have a more expensive sensing module that remains separate from the system, but the electrodes themselves can be disposable. A single bottle of ink could provide enough material to paint multiple electrodes over the course of several days or a week."

The team plans to continue developing their electrodes to potentially enable more advanced health sensing of biomarkers like cortisol or glucose. Cheng said that in addition to investigating a path towards commercial use for healthcare providers like paediatricians, the team is investigating unique applications, notably in the field of plant science, to create 'smart plants' that can offer scientists detailed information on chemical exposure in an environment, and the impacts that exposure might have on a plant's health.



Using a conductive, face-paint-like ink, researchers can now paint electrodes to monitor a wearer's heart, muscle or brain activity in style.

Image credit: Wanjing Zhang



The team has painted sensors in all sorts of different designs and colours, including animals like the fox, among other cute characters.

Image credit: Wanjing Zhang

AI-powered tablet

Getac has launched the new G140 tablet, a fully rugged Copilot+ PC1, in Australia and New Zealand.

Powered by AMD Ryzen technology, the G140 is designed for professionals working in industries such as public safety, automotive and manufacturing, who require versatile field-ready devices that can run demanding edge AI applications in a wide range of operational environments.

The G140 Copilot+ PC provides greater deployment flexibility for customers with specific integration requirements, while enabling their IT environments to remain unified and efficient.

The G140 is engineered for productivity in the field. Featuring an AMD Ryzen AI 5 340 / 7 350 CPU, AMD Radeon 840M / 860M GPU, and AMD XDNATM 2 NPU (up to 50 TOPS), it delivers AI-powered processing performance and high-quality visuals directly at the point of work. This advanced AMD architecture also provides battery endurance to support long shifts between charges without compromising power.

The G140 is designed to handle demanding field applications with high levels of responsiveness. Its integrated graphics capabilities allow professionals to view high-resolution maps and complex schematics with superb clarity, eliminating the need for a separate GPU. Extensive communication options, including Wi-Fi 7, Bluetooth 5.4, 4G LTE (optional), 5G Sub-6 (optional) and dual-SIM (optional) keep users connected in even remote locations, while two USB 4 ports as standard support high-speed data transfer, high-resolution video output and power delivery.

The G140 also features Getac's hot-swappable battery technology and can accommodate high-capacity batteries (optional) for long periods of uninterrupted use. A suite of security features including TPM 2.0, Windows Hello face-authentication camera, AMD PRO (optional), HF RFID reader (optional), fingerprint reader (optional) and smart card reader (optional), keep sensitive data safe at all times.

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Industrial edge AI computer

Backplane Systems Technology has introduced the Vecow ECX-4000 Series, a high-performance industrial edge AI computer built for machine vision, connected automation and intelligent industrial applications. Designed to deliver advanced processing at the edge, the ECX-4000 Series combines strong performance with industrial connectivity and rugged deployment features.

This platform is suitable for multi-camera machine vision systems, logistics automation, smart manufacturing and vehicle-based computing applications where fast local analysis is essential. By processing data closer to the source, the ECX-4000 Series helps support responsive AI workloads while reducing dependence on centralised computing infrastructure.

Its rich industrial I/O and networking flexibility make it a strong fit for system integrators who need a platform for demanding edge deployments. The series is also designed for harsh environments, making it suitable for industrial settings where vibration, temperature variation and power instability may be part of daily operation.

For organisations deploying AI at the industrial edge, the Vecow ECX-4000 Series provides a flexible foundation for machine vision, automation and next-generation industrial intelligence.

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Embedded computing module

Metromatics has released the WOLF VPX3U-AD5000E-CX7-optical high-performance embedded computing (HPEC) module to customers across Australia and New Zealand.

Designed for defence, aerospace and other mission-critical embedded applications, the rugged 3U VPX module combines an NVIDIA RTX 5000E embedded GPU with an NVIDIA ConnectX-7 SmartNIC to deliver accelerated artificial intelligence (AI), sensor processing and high-bandwidth optical networking within a compact SOSA-aligned platform.

The embedded computing module integrates advanced GPU processing with dual 40/100GbE optical fabric interfaces, reducing data movement bottlenecks between sensors, processors and storage.

Powered by NVIDIA's Ada architecture, the module features 9728 CUDA cores, 304 fourth-generation Tensor Cores and 76 third-generation RT Cores, supported by 16 GB ECC GDDR6 memory. The platform supports CUDA Toolkit 12, CUDA-X AI and CUDA-X HPEC libraries, enabling developers to accelerate AI inferencing, machine learning, high-performance embedded computing, image processing and sensor fusion applications.

Designed for deployment in demanding military environments, the conduction-cooled module operates from -40 to +70°C as standard, with operational capability up to +85°C. The design supports SOSA Aligned Payload Profile 14.6.11 with dual optical fabric connectivity and incorporates an onboard IPMI controller for system management together with hardware encryption features and secure networking capabilities.

The embedded computing module is designed for a range of applications, including C5ISR processing platforms, radar and electronic warfare systems, and high-speed optical networking and data acquisition systems.

Metromatics supplies WOLF Advanced Technology rugged embedded computing solutions throughout Australia and New Zealand.

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Cyborg cockroaches carry electronics into disaster zones

Image credit: The University of Queensland

'SWARMS' OF CYBORG COCKROACHES WITH CAMERAS AND MINIATURE MEDICAL INJECTORS COULD DELIVER SUPERVISED EMERGENCY CARE TO PEOPLE TRAPPED IN COLLAPSED BUILDINGS, CAVES OR OTHER PLACES TOO DANGEROUS FOR RESCUERS TO REACH.

Above: Biorobotics researchers from UQ have transformed North Queensland giant burrowing cockroaches (*Macropanesthia rhinoceros*) into miniature cyborg paramedics.

The 'Paraborgs' developed by University of Queensland biorobotics researchers, working with biomedical engineers at the University of New South Wales (UNSW), move cyborg insects of the future beyond searching for survivors to actively assisting them.

UQ biorobotics engineer Dr Thang Vo-Doan said their research transforms the cyborg insect from a mobile sensor into a tiny rescue platform, while critical medical decisions remain under human control.

"Cyborg insects have been designed for 'search and explore' missions for the past couple of decades," Dr Vo-Doan said.

The researchers equipped North Queensland giant burrowing cockroaches (*Macropanesthia rhinoceros*) with lightweight electronics and either cameras for visual feedback or remotely activated auto-injection systems custom-made for the species.

"Augmenting their natural biomechanics could allow these

cyborg insects to deliver timely emergency assistance when direct access to people trapped in narrow, debris-filled spaces isn't possible," Vo-Doan said.

In proof-of-concept testing at UQ's School of Mechanical and Mining Engineering, the paraborgs achieved 95% success with close-range injection — positioned within 15 centimetres of the target.

The complete navigation-and-injection task succeeded in 72% of trials.

"The cyborg insect has to navigate to the target, position itself accurately and remain stable enough to perform the injection. A lot of people might not like the sight of a giant cockroach scurrying towards them, but if you're trapped in rubble or stuck in a cave and need help, it could make a real difference between life and death," said PhD candidate Hai Nhan Le.

>

Unlocking new tools with insect biomechanics

Director of the UNSW Medical Robotics Lab Associate Professor Thanh Nho Do said the paraborg technology could extend the reach of emergency medicine.

"From a biomedical perspective, the opportunity is to bring treatment to a patient when the patient cannot yet be brought to treatment. The long-term goal is targeted, human-supervised intervention in places conventional medical technologies cannot access," Do said.

Vo-Doan added that the research demonstrates the UQ Biorobotics Lab's ability to adapt cyborg technology across different insect platforms.

The team has previously demonstrated cyborg beetles capable of controlled climbing, while the larger cockroaches provide greater capacity to carry specialised rescue and medical equipment.

The cockroaches, like the team's previous cyborg insect models, are anaesthetised during electrode and microchip fitting and live for as long as other cockroaches once the harnesses are removed.

Superintendent Tim Hassiotis, Manager Natural Disaster and Humanitarian at Fire and Rescue NSW, said the technology could extend the reach of rescue teams.

"If cyborg insects can safely enter spaces we can't, locate casualties and ultimately help deliver emergency care, they could become another valuable tool in the future of urban search and rescue," Hassiotis said.

A swarm with specialised roles

Vo-Doan said the longer-term vision was to deploy swarms of specialised cyborg insects, with individuals performing complementary roles.

"Some could carry cameras and environmental sensors, while others could carry specialised emergency or medical equipment," he said.

"The vision is not to replace first responders, but to give them another way to see, reach and potentially help people when direct access is impossible.

"Hopefully, within the next 5 to 10 years, we could see cyborg insect rescue teams deployed to help people in real emergencies, provided we have the resources to accelerate the research and field testing," Vo-Doan said.

The research findings have been published in *Advanced Science*.



Tabletop enclosures

OKW's new COMMUNITEC enclosure series provides a contemporary, high-capacity solution for large and heavy-duty electronic installations. With an ergonomically inclined operating surface of 12°, the table-top enclosure is suitable for displays from 11.5–14". An integrated handle facilitates transport — particularly practical for mobile applications in medical technology, such as patient monitoring, ventilation or neuromonitoring devices. COMMUNITEC also has a range of applications in aesthetic medicine as well as in laboratory, environmental and automation technology.

Available in two sizes — 'S' (283 x 246 x 194 mm) and 'M' (344 x 274 x 219 mm) — the enclosure offers plenty of space for large components. The inclined front panel enables readability from multiple viewing angles while providing effective protection for membrane keyboards. The flat surface underneath is suitable for control elements or printing. There is a recessed area on the rear to protect connections.

The enclosure consists of four individual parts made of UV-resistant ASA+PC-FR material — lightly textured and easy to clean — and is available in traffic white (RAL 9016) or anthracite grey (RAL 7016). The 'recessed handle cover' is also available in traffic grey A (RAL 7042). Individual parts are ordered separately and can therefore be colour-coordinated.

Service-friendly assembly is achieved using stainless steel Torx screws positioned at the rear and interior, maintaining the clean, uninterrupted design of the front panel.

Various mounting options are available for installing large-volume components. The base plate can also be pre-assembled outside the enclosure. Further assembly steps can be carried out via the handle opening or the front. Rubber feet provide a secure footing. Individual modifications in OKW's in-house service centre turn the standard enclosure into a customised product. Whether mechanical processing, EMC protection, various printing processes, laser marking and much more — there are many options available to create your customised enclosure.

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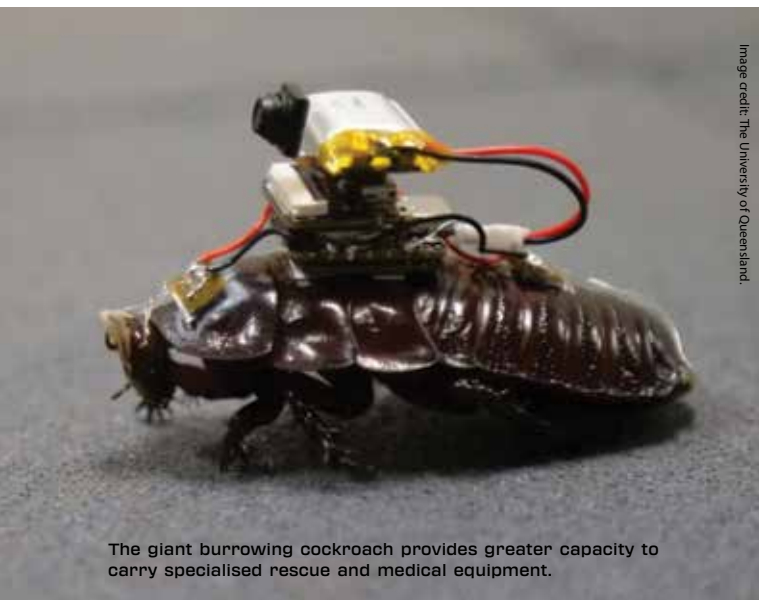


Image credit: The University of Queensland.

The giant burrowing cockroach provides greater capacity to carry specialised rescue and medical equipment.

Low-noise gearheads

FAULHABER has expanded its GPT gearhead family with the introduction of the 22GPT LN and 32GPT LN low-noise gearheads. Designed for applications where acoustic performance is critical, the new models are suited to laboratory automation, medical devices, optical systems and test and measurement equipment.

The gearheads combine compact dimensions with high torque capability, delivering up to 2.2 Nm and 8 Nm respectively in intermittent operation. An optimised gear design featuring a plastic input stage enables noise reductions of up to 10 dB compared with standard GPT gearheads, while maintaining the performance and durability of the FAULHABER GPT range.

Both models feature a robust stainless-steel housing and are designed to operate across a temperature range of -30 to +110°C. High efficiency under varying load conditions makes them suitable for demanding motion control applications requiring quiet operation without compromising torque output.

The gearheads provide equipment designers with a practical solution where compact size, high performance and low acoustic emissions are equally important.

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Assembly platform

With the SIPLACE V assembly platform, ASMPT has developed a new generation of placement machines that enables productivity increases under real-life conditions in several key industries while also meeting the rising requirements of modern electronics applications, such as AI server boards. It can handle large and heavy high-performance BGAs, oversized circuit boards and highly miniaturised components down to the 016008M size factor precisely and efficiently.

With a compact footprint of just 1.5 x 2.4 m, the placement platform processes odd-shaped components (OSCs) up to 55 mm in height. Existing SIPLACE X feeders and even changeover tables from the SIPLACE SX can continue to be used, providing electronics manufacturers with a high level of investment protection. An enhanced Smart Pin Support, increased maximum PCB size and a flexibly interchangeable tray changer further expand application versatility and simplify adaptation to changing production requirements.

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Polycarbonate enclosures

The polycarbonate 1557 family is available from Hammond Electronics in four plan sizes, each in two heights and sealed to IP68. The sizes are 80 x 80 x 45 mm and 60 x 120 x 120 mm, 160 x 160 mm and 200 x 200 mm in heights of 45 and 70 mm. All versions are available in black and RAL 7035 grey.

Rounded corners and top face give a smooth modern style, and environmental sealing allows the enclosures to protect the housed equipment against dust and water entry in dirty and damp environments. The 1557 can be used as a freestanding enclosure when fitted with the supplied feet, or it can be wall-mounted with either four visible fixings or two hidden ones. PCB standoffs are provided in both the lid and base. The enclosure is assembled with corrosion-resistant M4 stainless-steel machine screws, which are threaded into integral bushes for repetitive assembly and disassembly. The IP68 polycarbonate enclosures are also UV stabilised for outdoor use with a UL94-5VA rating.

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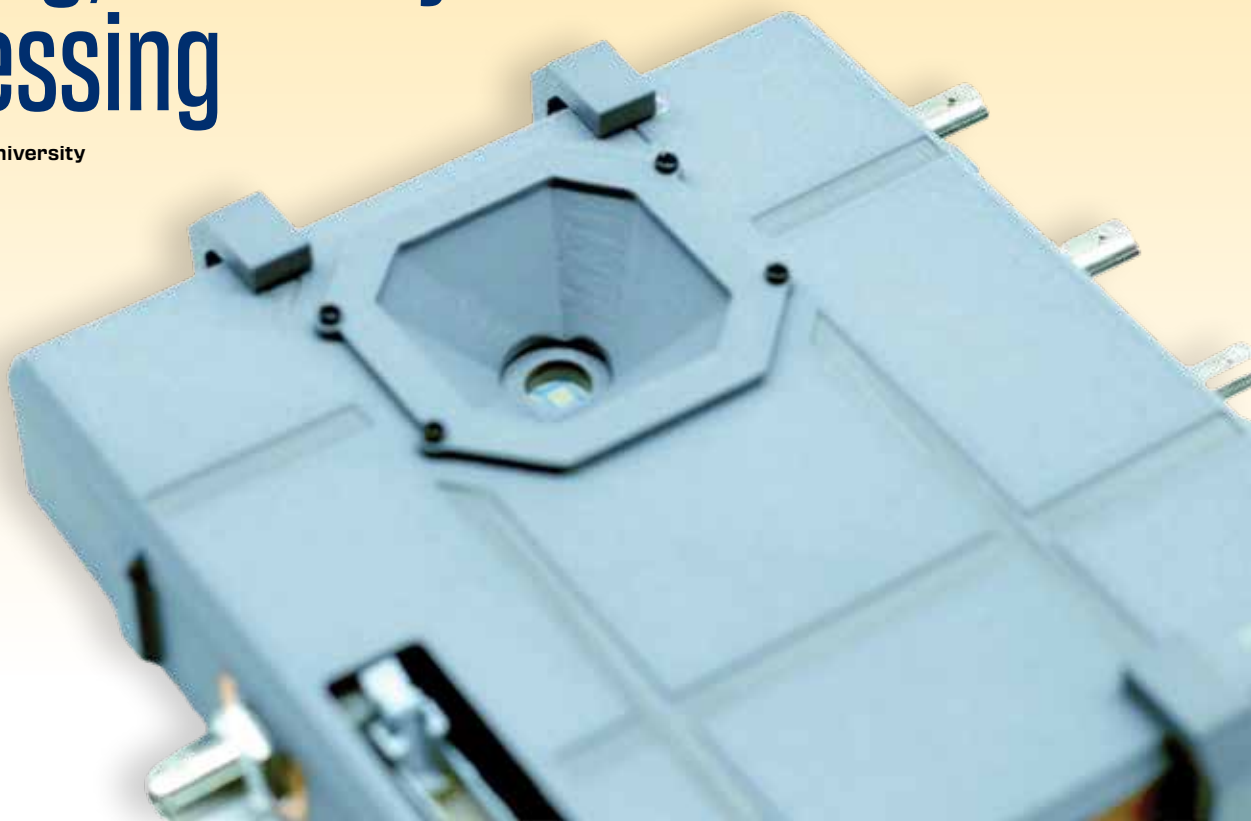
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Neuromorphic chip combines sensing, memory and processing

Will Wright, RMIT University



A WORKING PROTOTYPE THAT CAN SEE, REMEMBER AND INTERACT WITH THE WORLD LIKE THE HUMAN BRAIN COULD ONE DAY UNDERPIN SMART BIONIC EYES, WHILE USING FAR LESS ENERGY THAN TODAY'S TECHNOLOGIES.

The invention from RMIT University combines sensing, memory and information processing within the same system, reducing the need to constantly move data between separate sensors, memory banks and processors.

While still an early-stage research demonstration, the neuromorphic vision innovation could dramatically reduce the amount of data and energy required to perform complex visual tasks.

RMIT has an international patent application filed under the Patent Cooperation Treaty (PCT) for the invention.

Led by Professor Sumeet Walia at RMIT's Centre for Opto-electronic Materials and Sensors (COMAS), the work builds on breakthroughs involving super-thin semiconductor materials that could

underpin advanced robotics and low-energy AI systems.

"Nature has already solved many of the challenges we're trying to address in electronics. The human eye and brain work together incredibly efficiently, processing vast amounts of information using remarkably little energy. Our research is helping lay the foundations for technologies that work in a more similar way," Walia said.

A prototype that sees, remembers and engages with its environment

Unlike a conventional camera, which captures every frame and sends large amounts of information elsewhere for processing, the RMIT prototype is designed to perform much of that work where the information is collected.

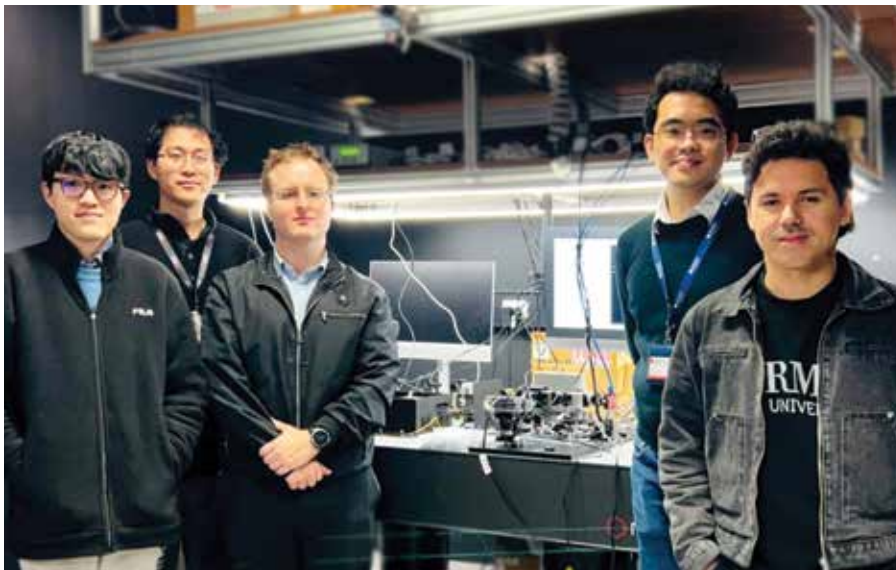
The prototype is built on a series of advances using the atom-thin semiconductor molybdenum disulfide (MoS_2). The sensing, processing and storage of information all takes place in a 2 x 2 cm chip, which is housed within a 15 x 14 x 3 cm prototype containing the electronics needed to read, process and communicate information.

Researchers have trained the system to recognise patterns including numbers, shapes and movement. In lab tests, it can detect changes in what it sees, store that information as memory and process it locally.

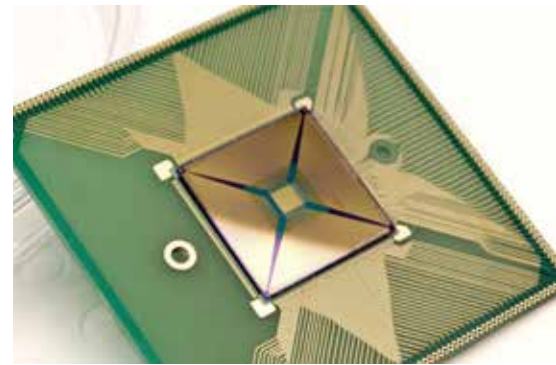
Dr Taimur Ahmed, co-researcher and expert in neuromorphic vision devices at RMIT, said the result was a system that more closely mimics the way biological vision works.

"This is not just a sensor that captures information, it's a sensor that can also

Images credit: RMIT University.



Members of the RMIT research team behind the neuromorphic vision prototype.



The sensing element at the heart of RMIT's neuromorphic vision technology.

process information. Rather than constantly moving data between separate memory and processing units, much of that work happens much closer to where the information is generated," Ahmed said.

A smart bionic eye would need to do more than simply capture images. It would need to identify important changes in a scene, store relevant information and process visual signals rapidly while using very little energy.

The RMIT technology could address these challenges by allowing visual information to be filtered and interpreted at the point of sensing, reducing the amount of data that needs to be transmitted and processed elsewhere.

The team's latest breakthrough also tackled another critical challenge: manufacturing.

They developed a cleaner, water-based fabrication process that transfers atom-thin semiconductors and electrodes with significantly fewer defects than conventional methods, producing devices with substantially improved electrical and light-sensing performance.

A vision for the future

While practical applications remain years away, researchers believe the technology could also eventually support advanced machine vision systems, autonomous

vehicles, robotics and intelligent sensors.

The work may also point towards a more sustainable future for artificial intelligence.

As AI drives demand for increasingly large and energy-intensive data centres, neuromorphic systems offer a different approach by processing information closer to where it is collected and reducing the amount of data that needs to be transmitted, stored and analysed.

"This work combines advanced materials, engineering and artificial intelligence to address one of the defining challenges of our time: creating intelligent systems that are both powerful and sustainable. If this RMIT technology can be scaled up, it could help reduce the amount of data that needs to be moved, stored and processed, making future AI systems more energy efficient," Walia said.

Digital module

Metromatics now supplies the Acromag QMC470 TTL Digital I/O Module, providing high-density digital interfacing for embedded computing applications across Australia and New Zealand.

Developed for the VITA 93 QMC (Q-Module Compact) mezzanine standard, the digital module delivers 40 bidirectional TTL/CMOS digital I/O channels in a compact form factor for embedded systems where size, weight, power and cost (SWaP-C) are critical design considerations. The module is suitable for aerospace, defence, industrial automation, transportation, scientific research and test and measurement applications.

Each of the module's 40 channels can be individually configured as either an input or output, providing flexibility for a range of digital monitoring and control functions. Integrated programmable interrupt generation, input debounce filtering and output readback capabilities simplify system integration while improving signal reliability in demanding embedded environments.

The QMC470 forms part of Acromag's growing family of VITA 93 QMC modules, providing system designers with a compact alternative to larger mezzanine standards while maintaining the performance required for next-generation embedded computing platforms.

Metromatics supplies Acromag embedded computing and industrial I/O solutions throughout Australia and New Zealand, providing local engineering support and technical assistance for defence, industrial automation, transport, research and OEM applications.

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This computer displays flight path information, along with other critical flight data for the pilots in the cockpit. The screen displays “bus driver” to show that the researchers have control of it.

Image credit: Erik Jepsen, University of California San Diego.

Hardware implant exposes new risk in aircraft electronics

Ioana Patrington, University of California San Diego

PHYSICAL ACCESS TO AN AIRCRAFT HAS NOT TYPICALLY BEEN CONSIDERED A CYBERSECURITY RISK — BUT IT SHOULD BE, ACCORDING TO A TEAM OF COMPUTER SCIENTISTS AT THE UNIVERSITY OF CALIFORNIA SAN DIEGO.

In a paper presented at the USENIX Security Symposium in Baltimore, Md, former UC San Diego PhD student Sam Crow showed that physical access to an aircraft — even for a brief period of time — would allow an attacker equipped with a custom-made hardware device to take over the communications between two key onboard computers.

The device needs to be plugged into a port inside the plane’s belly — an action that the researchers estimate would take under 60 seconds. This would require access to the aircraft either when parked at a gate or when in an airport hangar during regular maintenance. Access to these areas is controlled carefully but not always

successfully, the computer scientists noted in the new paper.

The researchers successfully demonstrated the attack on a testbed made of actual Boeing 737 airplane parts and airplane software. The proof-of-concept attack allowed researchers to change the plane’s flight path and change data that could make take-off conditions unsafe. But they are careful to note that the attack requires someone to do significant planning and engineering work ahead of time. The research team communicated closely with Boeing, disclosed the vulnerability in 2020, and further tested and validated their findings in Boeing’s own lab.

Of note, the Boeing 737 is one of the most used aircraft in commercial aviation, with 8000 in service today. However, while the team’s implementation is designed for the Boeing 737 specifically, the researchers believe their findings are relevant for the aviation industry more generally.

“Our goal with this research is to alert the aviation community to this class of risks, so they may be appropriately mitigated well before they become dangerous. All of the authors of this paper routinely travel on Boeing 737 aircraft and expect to continue doing so,” said UC San Diego computer scientist and cybersecurity expert Aaron Schulman, one of the senior authors of the work.

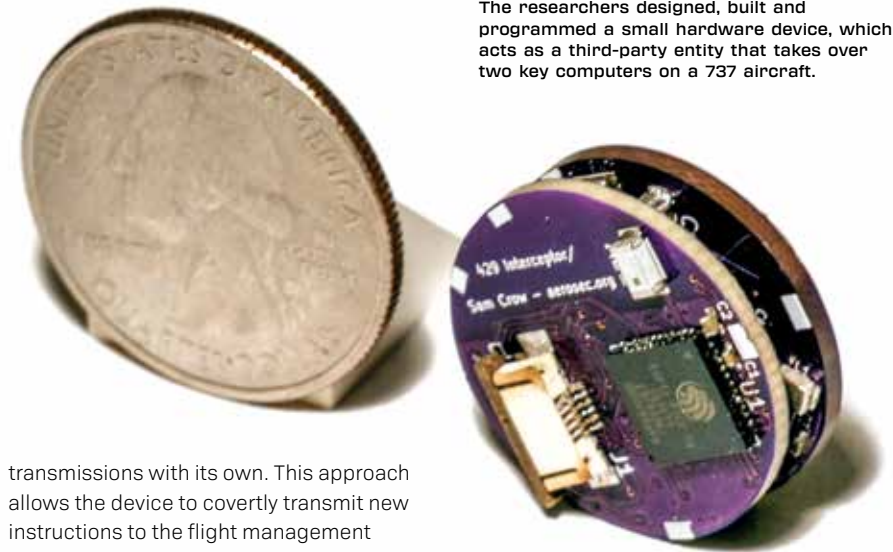
How does the attack work?

The researchers discovered an unused maintenance port located in the plane's Electronics and Equipment bay, which houses key electronic systems. This bay is located just under the plane's nose, can be reached from the ground, and isn't locked. This maintenance port provides access to the data transmitted between two critical onboard computers.

One computer is the flight management computer, which controls the plane's flight path as well as approach path before landing and also supplies critical information at take-off. The other is the computer that displays this flight path information, along with other critical flight data for the pilots in the cockpit. Information and instructions to and from these two computers is ferried by hard-wired communication systems known as buses — in this case, two ARINC 429 buses, which were invented in 1977.

Buses, like the ARINC 429, convey data via current flowing through two wires and a set of resistors. Because the system is decades old, it does not have data security features, such as message authentication.

The researchers designed, built and programmed a small hardware device, which acts as a third-party entity that takes over these buses. It does so by driving more current so it can override any legitimate



The researchers designed, built and programmed a small hardware device, which acts as a third-party entity that takes over two key computers on a 737 aircraft.

Image credit: University of California San Diego.

transmissions with its own. This approach allows the device to covertly transmit new instructions to the flight management computer while suppressing indications that changes have been made.

Using their proof-of-concept demonstration, the researchers showed that their implant could re-route a plane in flight or modify data about weight, balance and temperature, which could lead to an unsafe take-off. While pilots could override such changes, it would require that they detect that a compromise had occurred.

View video of researchers using a physical device to take over electronics in a Boeing 737.



Filtered circular connectors

The Spectrum Control custom EMI-filtered MIL-DTL-38999 connectors are designed to meet demanding military, aerospace and high-reliability application requirements. Spectrum Control has developed an expedited design-to-delivery process that produces fully customised filtered connectors in only 12 to 14 weeks with zero NRE charges.

These next-generation connectors provide high-performance EMI filtering, rugged construction and complete configuration flexibility, enabling designers to streamline development cycles while meeting environmental and electrical performance standards.

The filtered circular connectors feature a combination of advanced technologies and robust construction, including EMI filtering using both planar and substrate-based designs, outperforming chip-on-board or chip-in-seal alternatives. With soldered construction for improved high-frequency integrity, the connectors also feature durable aluminium shells for weight-sensitive or harsh environmental applications. A wide capacitance range also supports both power and signal filtering in a single connector.

All filtered connectors undergo quality assurance testing, including capacitance, dissipation factor, dielectric withstanding voltage and insulation resistance — many performed 100% by computer-controlled systems for consistent compliance with MIL-STD requirements.

The standard product attributes include a square-flange wall mount format, PC-tail terminations, N-keying, 5-amp current rating, size 22D contacts and DWV ratings of 200 VDC working/500 VDC maximum.

Custom EMI-filtered MIL-DTL-38999 connectors are available now through Richardson RFPD.

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New method enhances quantum error detection accuracy

University of New South Wales

A TEAM OF RESEARCHERS FROM UNSW SYDNEY HAS DEVELOPED A NEW WAY TO CHECK FOR ERRORS IN QUANTUM COMPUTERS WITHOUT SIGNIFICANTLY DISRUPTING THE FRAGILE QUANTUM INFORMATION THEY RELY ON.

The researchers riffed on the famous Schrödinger's cat analogy to demonstrate a more efficient way to eliminate errors in quantum computing.

"Imagine you're trying to find your cat hiding in one of eight identical cardboard boxes, in a dark and noisy room," said UNSW Scientia Professor Andrea Morello.

"You are not allowed to enter the room — opening the door may kill the cat. What is the optimal strategy to find out where it's hiding? Our team of quantum researchers have found an answer to this problem, and it might be an important milestone on the road to building a quantum computer."

The cat metaphor has been used for decades to illustrate the quirky phenomena that occur when attempting to apply quantum mechanics to macroscopic systems.

In a UNSW-led study the 'cat' is the nucleus of an atom of antimony, implanted in a silicon quantum chip. Although atomically small, the antimony nucleus has eight quantum states that can be used to encode quantum information.

Having eight different states leaves extra room to detect and correct errors that may occur during the calculation.

Improving quantum error correction is a major hurdle in building large-scale quantum computers.

"The quantum states used to encode the information are called, indeed, 'Schrödinger cat' states. The key remaining problem is finding out an error has occurred, without disrupting the precious information encoded in the atom — or 'cat'," Morello said.

Just add 'water'

To explain how this problem was solved, Morello said to imagine the cat in the dark room.

"In this scenario, you cannot enter the room and look inside, so instead you could place eight sprinklers in the room, each placed above one of the boxes. You then spray some water over each box, in sequence, and listen for an angry 'meow' when the cat expresses displeasure for being sprayed. But because the room is noisy, you might mistakenly think that a meow came from an empty box — or miss registering a true meow coming from the box containing the cat."

He said the standard method to reduce the chance of such mistakes is to repeat the whole experiment several times, and infer the cat is in the box where the most meows came from.



The approach could improve 'mid-circuit' measurements used in quantum error correction.

However, spray too often and the cat might panic and jump to another box.

"Repeatedly sprinkling the boxes risks changing the very thing you are trying to observe," Morello said.

The trick, according to Morello, is to stop immediately once the first 'meow' is observed — this is your initial guess — and switch to sprinkling only the boxes where the cat supposedly isn't.

"Silence from those boxes increases the confidence that your guess was correct. The absence of a signal confirms the presence of another, without interacting directly with the system. Sometimes, silence can be loud," Morello said.

Back to the science

In the physical system used by the researchers, the 'sprinkler' is an electron that can be pushed onto the atom and then removed from it conditionally on the quantum state of the nuclear spin.

The addition and removal of the electron can unsettle the nucleus and make it jump to a different state.

When the new strategy is applied to the 'atomic cat', the electron only needs to come off the atom once. After that, only the empty states are probed.

This method more than halved the chance of error, and it cut the total measurement time to a third.

Lead author Arjen Vaartjes said using this adaptive measurement strategy, the team managed to boost the confidence of 'finding the cat in the right box' to 99.61%.

"This value is significant because it puts our system in the range of measurement fidelities necessary to perform successful quantum error correction," Vaartjes said.

"Quantum error correction relies on repeated measurements without disrupting the fragile quantum information, equivalent to finding the cat in the right box without scaring it," Morello said.

By changing their measurement strategy, the team showed it is possible to extract more information while causing less disturbance — an essential step towards utility-scale quantum computing.

The team said the approach could improve 'mid-circuit' measurements used in quantum error correction, which is a major challenge in developing scalable quantum computers for applications such as drug discovery, simulation of chemical reactions, optimisation of financial portfolios and machine learning.

A trick any quantum lab can use

Morello said the broader impact of the work is that it can be applied to a wide range of other quantum computing systems.

"This adaptive measurement approach may help significantly reduce measurement errors in systems ranging from semiconductor qubits to atomic or photonic architectures. Because many architectures also employ similar hardware, the new protocol can readily be adapted to other platforms that suffer from errors during measurement," Morello said.

Morello added that scalable quantum computing may ultimately depend on how well we learn to 'find the cat in the right box' without disturbing it.

"We can now extract information about the quantum system just gently enough to keep it intact," Morello said.



Single board computer

Metromatics, the exclusive Acromag partner in Australia and New Zealand, has launched the Acromag XVME-6800 6U VME single board computer (SBC).

Designed to modernise existing VMEbus systems, the single board computer allows organisations to introduce current processing technology while retaining compatible VME backplanes, specialist I/O boards and other established system infrastructure.

VME technology remains widely deployed in defence, aerospace, transportation, research and industrial applications. However, the processor boards within these systems may no longer provide the performance, connectivity or long-term availability required for modern workloads. The XVME-6800 provides an upgrade path that can extend the operating life of these systems without the risk of a complete platform redesign.

Powered by an 11th-generation Intel Tiger Lake-H Xeon W processor, the board provides eight processing cores and 16 threads. It also includes 32GB DDR4 ECC memory, onboard NVMe storage and an FPGA-based VME-to-PCIe bridge.

Two PMC/XMC mezzanine sites allow engineers to add specialist processing, communications and I/O capabilities. These may include FPGA processing, data acquisition, video capture, high-speed networking or platform-specific interfaces. The XMC sites support PCI Express Gen4 x8 connectivity.

Potential applications include defence platform sustainment, radar and electronic warfare, C5ISR processing, flight test, simulation, scientific instrumentation, transportation systems and industrial automation.

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Pressure shown to extend EV battery lifespan

Such gains are unheard of in battery development, where tweaks to battery composition usually result in gains of 5–10%. Extending the lifetime of electric vehicle (EV) batteries would not only reduce the rate at which they end up in landfill or recycling, but would also reduce the environmental pressures associated with nickel or cobalt mining.

However, the pressure needs to be just right — too much or too little will cause the batteries to fail. The researchers built a custom device to keep the pressure on the battery in this ‘Goldilocks’ zone, without the need for any specialised chemistry. Their results are reported in the journal *Nature Energy*.

At their most basic level, lithium-ion batteries are composed of an anode, a cathode and an electrolyte. As the battery goes through each charge and discharge cycle, lithium ions shuttle from the anode to cathode and back again. This causes the battery to physically expand and contract, almost like breathing.

“Batteries don’t tend to like this cycle of stress and release,” said Professor Michael De Volder from Cambridge’s Department of Engineering, who co-led the research. “Much of the work on improving lithium-ion batteries is done by chemists and physicists, but as a mechanical engineer, I also wanted to look into the role that mechanics play.”

To study this, De Volder and his colleagues built a device that squeezes a type of battery known as a pouch cell using

RESEARCHERS LED BY THE UNIVERSITY OF CAMBRIDGE STUDIED THE ROLE OF PHYSICAL PRESSURE ON THE LIFETIME OF LITHIUM-ION BATTERIES AND FOUND THAT KEEPING BATTERIES UNDER CONSTANT PRESSURE COULD DOUBLE THEIR LIFESPAN.

pneumatic ‘bellows’: small air-filled cushions that act like a self-adjusting clamp. The bellows maintain a continuous pressure, while a sensor monitors tiny volume changes as the battery charges and discharges.

“We just bought commercial batteries and tested them for lifetime under different pressures,” De Volder said. “We didn’t have to change anything about their electrolyte or electrode composition.”

They found that the pressure from the bellows needs to be in the ‘Goldilocks’ zone: about 12.5 bar, or roughly four times what’s standard in conventional coin cell batteries. Outside this zone, the batteries fail faster. If the pressure is too high, it can cause lithium plating to form on the anode, and too little can cause the cathode to crack.

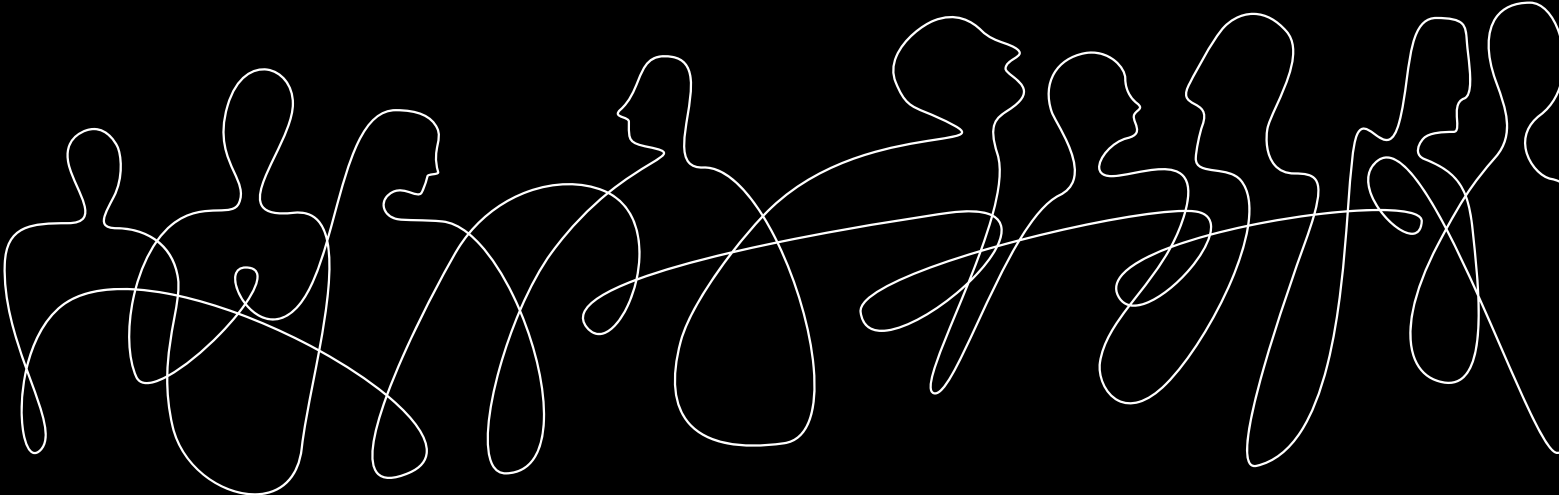
“We found that when you keep the pressure on them relatively constant throughout each charge and discharge cycle, it’s much better for the overall lifetime of the battery,” De Volder said. “If you press too hard, the anode is unhappy. If you don’t press hard enough, the cathode starts degrading. Our experiments identified where the ‘happy place’ is for batteries when it comes to pressure.”

The results, while early stage, could have important implications for the fast-growing EV market, especially in the second-hand market. “The longer your product will last, the fewer the number of times you’ll have to recycle the materials,” De Volder said. “And we are very bad at recycling batteries at the moment.”

In addition, longer-lasting EV batteries could reduce the volume of raw materials that need to be mined, often in extremely poor conditions, to produce new batteries. “We’ve produced a solution for cleaner electric cars, but we have to make sure that on the back of it, we are not creating new ecologic disasters in other parts of the world,” De Volder said. “If we can reduce the pressure on these mining operations a bit, that would be another important benefit.”

The technology has been tested at a laboratory scale, but will need to be scaled up for commercial battery applications. A patent has been filed by Cambridge Enterprise, the University’s innovation arm.

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Solder Paste Inspection (SPI)



Nitrogen Enabled SMT Reflow



Through-Hole AOI

