sensitivity as the Keck Array into a single unit. It has already started collecting data and will be fully operational by the end of February, when the Antarctic summer finishes. Like BICEP2, BICEP3 will look for B modes caused by gravitational waves, but with greater precision and sensitivity, allowing it to detect ever fainter imprints in the CMB. And it will search the sky at 95 gigahertz (GHz), a lower frequency than its predecessor: the joint analysis with Planck, which scans the sky at a variety of frequencies up to 857 GHz, suggested that dust should have less of an effect at 95 GHz, making it more of a "sweet spot" for seeing a primordial signal, says Bischoff.

Antarctica is the perfect place to look for tiny twists in cosmic light. Not only is the continent blessed with relatively clear skies, but its dry climate means that there is much less water in the air to absorb microwaves. Bischoff's colleagues are now working feverishly through the remaining Antarctic summer to get the detectors ready. Even the isolation can be an advantage, says Bischoff: "It's a good place to get work done, and it's pretty beautiful."

But BICEP3 and the Keck Array might be beaten by a rival. They point at the same region of sky as BICEP2, which turns out to be more polluted with dust than once thought. More luck might be had by the South Pole Telescope (SPT), which is less sensitive but scans the sky more widely and at a higher resolution, or the POLARBEAR telescope, installed in 2012 at the James Ax Observatory in Chile, says Peter Coles, a cosmologist at the University of Sussex, UK. "I wouldn't like to pick the likely winner," he adds. The SPT and BICEP teams are also working on a joint analysis: if the primordial signal is very weak, it will be harder to differentiate from another source of B modes known as gravitational lensing, which the SPT is optimized to study.

Anthony Challinor, a cosmologist at the University of Cambridge, UK, is upbeat about the BICEP team's chances. The researchers' growing experience in untangling the CMB and the results obtained at varying frequencies puts them in good stead. "This is a very competitive field and the competition is catching up, but the BICEP team is still ahead of the game."

How did the drama of the discovery affect the team? Acknowledging "some ups and downs" in 2014, Bischoff shrugs his shoulders. "Looking back, we probably could have been more cautious," he says. "But even with a low-key announcement there still would have been a large reaction one way or another." Despite the attention, he says, "I feel like mostly we've kept pretty steady". ■

Additional reporting by **Ron Cowen**.

MATERIALS SCIENCE

Silicene makes its transistor debut

Creation of electronic device using atom-thin silicon sheets could boost work on other flat materials.

BY MARK PEPLOW

Seven years ago, silicene was little more than a theorist's dream. Buoyed by a frenzy of interest in graphene — the famous material composed of a honeycomb of carbon just one atom thick — researchers speculated that silicon atoms might form similar sheets. And if they could be used to build electronic devices, these slivers of silicene could enable the semiconductor industry to achieve the ultimate in miniaturization.

This week, researchers took a significant step towards realizing that dream, by unveiling details of the first silicene transistor[1].

Although the device's performance is modest, and its lifetime measured in mere minutes, this proof of concept has already been causing a stir at conferences, says Deji Akinwande, a nanomaterials researcher at the University of Texas at Austin who helped to make the transistor. Guy Le Lay, a materials scientist at Aix-Marseille University in France, agrees.

"Nobody could have expected that in such a short time, something that didn't exist could make a transistor," he says.

Le Lay was one of the first scientists to create silicene in the lab[2], in 2012 (see 'The rise of silicene'). The debut coincided with a growing sense that graphene was unsuitable for making transistors. Graphene may be the world's most conductive substance, but it is missing a crucial characteristic. Unlike the semiconductors used in computer chips, it lacks a band gap — the energy hurdle that electrons must vault before they can carry a current. Band gaps enable semiconductor devices to switch on and off and to perform 'logic' operations on bits.

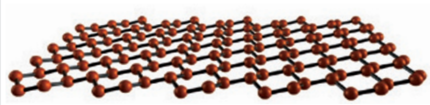
"For logic applications, graphene is hopeless," says Le Lay. By contrast, silicene can boast a band gap, because some of its atoms buckle upwards to form corrugated ridges, which puts some of its electrons in slightly different energy states. What is more, makers of electronic chips have been wary of ditching decades of silicon-manufacturing experience in favour of carbon, says Lok Lew Yan Voon, a theoretical physicist at the Citadel, the Military College of South Carolina in Charleston, who first named silicene and modelled its properties back in 2007 (ref. 3).

But handling silicene in the lab has been a huge challenge. The material cannot be peeled from a solid block using sticky tape, as graphene can from bulk graphite. Instead, researchers produce it by letting a hot vapour of silicon atoms condense onto a crystalline block of silver in a vacuum chamber, a much trickier process. And unlike robust graphene, naked silicene is extremely unstable in air, making it difficult to transfer the gossamer sheet to more useful substrates — such as the guts of a transistor. As recently as last year, some researchers were still questioning whether silicene even existed.

So Akinwande joined forces with Alessandro Molle at the Institute for Microelectronics and Microsystems in Agrate Brianza, Italy, to offer silicene some protection. They formed a silicene sheet on a thin layer of silver, and added a 5-nanometre-thick layer of alumina ▶

THE RISE OF SILICENE

Its carbon-based cousin graphene gets more attention, but silicene is catching up.



SOURCE: SILICENE LABS; IMAGE: REF. 1

1994 First calculation of the structure of two-dimensional crystals of silicon (pictured) and of germanium.

2004 Andre Geim and Konstantin Novoselov report isolation of graphene.

2007 The name 'silicene' is coined.

2009 Fabrication of silicene nanoribbons; flurry of theoretical papers on silicene and germanene begins.

2010 Geim and Novoselov bag Nobel Prize in Physics for their experiments on graphene.

2012 Six independent reports of silicene sheets (formed on silver).

2015 First demonstration of silicene transistor.

on top. Then they peeled this silicene sandwich off its mica base, flipped it silver-side-up, and laid it on an oxidized-silicon substrate. Finally, they gently etched away some of the silver to leave two islands of metal as electrodes, with a strip of exposed silicene between them.

"It's a very clever trick," says Le Lay, who is planning to try the process with germanene, a capricious, similarly structured 'two-dimensional' material made from germanium that his team created last year[4].

Clever it may be, but the transistor will not be making an appearance in mobile phones any time soon: the exposed silicene degrades in about two minutes. Still, that is long enough to measure its properties. Although its electrons are sluggish in comparison to graphene's, the device does indeed have a small band gap.

Laying an extra coating on top of the silicene transistor could also extend its life. Akinwande has used Teflon to help flakes of phosphorene — another air-sensitive, two-dimensional material, made of phosphorus — to survive for months[5]. Other researchers have shown that using multiple layers of silicene could allow the sacrificial top layers to protect those beneath for 24 hours[6]. Crucially, the technique used to make the silicene transistor could now help to test all of these ideas, and more, with various air-sensitive materials. "It's definitely a game-changer," says Lew Yan Voon. "This is the paper we've been waiting for in the field."

> ***"It's definitely a game-changer. This is the paper we've been waiting for."***

Not everyone is so enthusiastic about silicene's prospects. "There's a lot of talk about silicene, germanene and phosphorene," says Jari Kinaret of Chalmers University of Technology in Gothenburg, Sweden, who is the director of the European Union's Graphene Flagship, a €1-billion (US$1.1-billion) research project to study two-dimensional materials and develop applications for them, "but the difficulties with them are still quite substantial."

Le Lay, however, is convinced that researchers will flock to silicene. "Now that a device has been made," he says, "other scientists will see it is not a dream material, it is a practical thing." ■

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The King Abdullah University of Science and Technology is a stark exception to strict Saudi society.

SUSAN BAAGHIL/REUTERS

SAUDI ARABIA

Science oasis under pressure

But scientists at Saudi Arabia's leading university argue for a quiet approach to modernizing the nation.

BY DECLAN BUTLER

Following the high-profile flogging of Saudi Arabian activist Raif Badawi last month, the King Abdullah University of Science and Technology (KAUST) — a multicultural, world-class university in what seems an unlikely setting — is in the spotlight.

Badawi received 50 lashes, the first in a sentence that stipulates a total of 1,000 lashes plus 10 years in prison, as punishment for a website that he created for social and political discussion. As well as prompting an international outcry, the case has put KAUST's leaders under pressure to speak out about the lack of freedom of expression in Saudi Arabia, where KAUST is based. Researchers at the university, however, argue that they can have a bigger impact on Saudi society — and perhaps on the Arab and Muslim world broadly — by quietly continuing in their efforts to create a world-class centre for research and critical thinking.

"KAUST is built on values that I espouse as a scientist, and the impact of KAUST will be felt over time, in major part through the influence of its graduates," says Mark Tester, an Australian who is associate director of KAUST's Center for Desert Agriculture.

A graduate university, KAUST was founded in 2009 by the late King Abdullah, with the goal of establishing a culture of science and enlightenment in Saudi Arabia and beyond.

A stark exception to strict Saudi society, its campus in Thuwal, 90 kilometres north of Jeddah, imposes no discrimination on the basis of sex, religion or ethnicity. Unlike in the rest of the country, women and men mingle, and women can also drive. The freedoms on the campus were a condition of the prominent Western scientists who backed KAUST's development.

On 18 January, nine days after Badawi received the first lashes, 18 Nobel prizewinners from around the world wrote to Jean-Lou Chameau, the president of KAUST, calling on "influential voices in KAUST" to speak up for the freedom to dissent. The letter warns that KAUST's international ties could be at risk if the restrictions on freedom of thought and expression in Saudi Arabia continue.

One researcher familiar with KAUST, who requested anonymity because of the sensitivity of the issues, says that if KAUST researchers were to speak out or be politically active, it would have little effect on the regime and would risk providing ammunition for the institution's critics in Saudi Arabia. KAUST is controversial there, the researcher says,