

► 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 year⁴.

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 months⁵. Other researchers have shown that using multiple layers of silicene could allow the sacrificial top layers to protect those beneath for 24 hours⁶. 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."

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.

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 multi-cultural, 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,

SUSAN BAAGHLI/REUTERS

and the state and clerics have sought to keep the university and its scientists at a distance from domestic political or social issues. “It is always under a microscope from conservative elements,” says the researcher.

Scientists can do more for Saudi Arabia by working at KAUST than by criticizing it from outside, says Tester. “We are making a real contribution to the country through education, and through research advances.”

KAUST has attracted leading scientists from around the world to join its faculty of around 130, and has set up science centres to study regionally important issues such as desert agriculture, Red Sea research, desalination and solar energy. The campus now hosts 840 students from 69 countries, including 246 from Saudi Arabia and 302 women.

“My philosophy is that I don’t think I’m compromising, but modestly contributing to opening up things,” says another foreign researcher who requested anonymity.

Indeed, much of the international support that was crucial for KAUST’s development came with the understanding that Saudi Arabia would improve freedoms beyond the campus site. Yet, as the case of Badawi highlights, if anything, the kingdom seems to have stepped up its repression of freedoms since KAUST was founded.

There was a “spirit of hope” when KAUST

opened, says letter co-signatory John Polanyi, who won the 1986 Nobel Prize in Chemistry. But patience with the Saudi Arabian regime is now “wearing thin”. “I think the scholarly community has been slow to become aware that KAUST cannot be an island of freedom,” he says.

Tester argues that KAUST is educating a new generation of Saudi students, who will eventually help to transform

“We are making a real contribution to the country through education, and through research advances.”

for change in Saudi Arabia. A multibillion-dollar scholarship programme launched by King Abdullah in 2005, and set to continue until 2020, funds hundreds of thousands of Saudi undergraduates and postgraduates to study abroad. Scientists familiar with Saudi Arabia say that they suspect Abdullah’s plan was to produce a delayed benefit: after being exposed to alternative ideas and cultures, returning students would moderate Saudi society and ease the grip of conservative clerics. Education in the

kingdom more generally. “KAUST’s existence is evidence of the kingdom’s desire to develop,” he says. “It will take time, and I ask that people give us time.”

KAUST is not the only academic force

kingdom is heavy on religion. “It’s more Koran than periodic table,” says one researcher.

Although large numbers of Saudi men have long had Western educations, one big difference that the programme provides is that it is open to women. “That is what will be transformative,” says another foreign scientist who has worked closely with KAUST. “But it’s not going to happen overnight.”

Still, scientists inside and outside KAUST agree that the establishment of a knowledge-based culture and economy will require reforms by the Saudi leadership too. “The whole idea behind KAUST was that King Abdullah wanted Saudi Arabia brought back into the mainstream of science,” says one anonymous scientist. But modern science requires free thinking and creativity, and cannot flourish in a repressive culture, adds the researcher. “If Saudi Arabia is to take its place on the modern science and technology scene it really has to pay attention to its human rights.” ■

CORRECTION

The News story ‘Rave drug tested against depression’ (*Nature* **517**, 130–131; 2015) stated that ketamine acts by blocking the signalling molecule NMDA. The drug actually acts on the NMDA receptor.