MONASH University

MONASH INNOVATION

NEXT GENERATION LOW ENERGY TRANSISTORS

A method of forming a topological Dirac semimetal layer on a substrate. The topological transistor is switched from conventional insulator to topological insulator via an electric field with a tuneable bandgap. The new system aims for a ten-fold improvement in energy efficiency.

- **Novel IP on 2D materials**
- **Demonstrated Bandgap and Switching**
- **Awarded $34 million Australian Research Council Centre of Excellence (2017)**
- **14 Australian and International Science Centers**

THE CHALLENGE

Until recently, the challenge for computing has been size and speed; as an example, IBM announced their 7nm chip in late 2016. However, the next big challenge is not faster or smaller computing, but more efficient energy usage.

Energy usage for computing has been recognized by the Breakthrough Energy Fund as one of the world's major problems that need future solutions (Technical Quest: Extreme Efficiency in IT/ Data Centers).

Carbon dioxide (CO_2) emissions are linked to climate change. While energy production and chemical industries are the major CO_2 producers, large Data Centers and computing technology in general are also contributing to CO_2 emissions and energy needs; this is a fast growing problem.

- By 2020, emissions from Data centers are projected to reach >320 metric tons CO_2-equivalent per year, more than four times the CO_2 emissions in 2007.

THE TEAM

ARC Laureate Fellow at Monash, Prof Michael Fuhrer is the Director of the Centre of Excellence and one of the lead inventors on the new IP. Dr. Mark Edmonds, ARC DECRA Fellow at Monash University, is a world-leading expert in topological Dirac semimetal thin films.

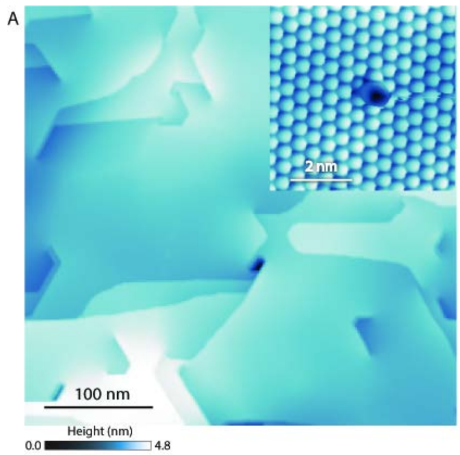

Figure 1. Epitaxial thin film of topological Dirac semimetal Na_3Bi on silicon (Image taken with scanning tunnelling microscope.)

THE TECHNOLOGY

The aim for this system is a ten-fold improvement in energy efficiency according to Moore's Law.

We envision a topological transistor in which an electric field from gate electrodes switches a material from conventional insulator to topological insulator. In the topological insulator, current will be carrier by ballistic 1D edge modes.

We have developed a method of forming a topological Dirac semimetal layer on a substrate (Fig. 1).

Using this 2D material we have developed an electric field-effect structure which can be used to alter the charge carrier density and band gap in a topological Dirac semimetal film. In an ultrathin topological Dirac semimetal we can tune the bandgap by over 400 meV, from conventional insulator to topological insulator, realizing a platform suitable for a topological transistor. (Fig. 2).

Intellectual property: International patent filed in 2017 (PCT/AU2017/050399).

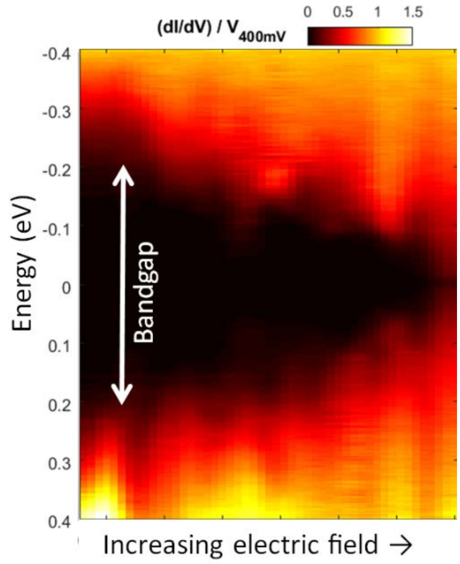

Figure 2. Tuning bandgap of ultrathin Na_3Bi with electric field.

THE OPPORTUNITY

Monash is actively seeking expert Industry Advisors to ensure that this program has commercial value and is meeting industry's future needs.

Monash will consider licensing and/ or partnering opportunities to develop this technology further.

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Produced by Monash Innovation: February 2018