Atomically thin 'switch' makes for smarter electronic devices in the future

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(PhysOrg.com) -- A new transistor made from graphene - the world's thinnest material - has been developed by a research team at the University of Southampton.

The new transistor achieves a record high-switching performance which will make our future electronic devices - such as PDAs and computers - even more functional and high-performance.

In a paper published in *Electronics Letters*, Dr Zakaria Moktadir of the Nano research group at the University describes how his research into graphene, a material made from a single atomic layer of carbon, arranged in a two-dimensional honeycomb structure, led to the development of graphene field effect transistors (GFETs) with a unique channel structure at nanoscale.

According to Dr Moktadir, in the context of electronics, graphene could potentially replace or at least be used side by side with silicon integrations.

"Silicon CMOS downscaling is reaching its limits and we need to find a suitable alternative," he says.

"Other researchers had looked at graphene as a possibility, but found that one of the drawbacks was that graphene's intrinsic physical properties make it difficult to turn off the current flow."

Dr Moktadir discovered that by introducing geometrical singularities (such as sharp bends and corners) in bilayer graphene nanowires, the current could be turned off efficiently.

According to Professor Hiroshi Mizuta, Head of the Nano group, this engineering approach has achieved an on/off switching ratio 1,000 times higher than previous attempts.

"Enormous effort has been made across the world to pinch off the channel of GFETs electrostatically, but the existing approaches require either the channel width to be much narrower than 10 nanometres or a very high voltage to be applied vertically across bilayer graphene layers," he says.

"This hasn't achieved an on/off ratio which is high enough, and is not viable for practical use."

Dr Moktadir developed this transistor using the new helium ion beam microscope and a focused gallium ion beam system in the Southampton Nanofabrication Centre, which has some of the best nanofabrication facilities in the world.

"This is a breakthrough in the ongoing quest to develop advanced transistors as we progress beyond our current CMOS technology," says Professor Harvey Rutt, Head of Electronics and Computer Science.

"It will have major implications for next generation computer, communication and electronic systems. Introducing geometrical singularities into the graphene channel is a new concept which achieves superior performance while keeping the GFET structure simple and therefore commercially exploitable."

Having created the transistor, Dr Moktadir is now undertaking further research to understand the mechanism which causes the current to stop flowing in the channel, testing its reliability and performance under various noise and temperature conditions.

Provided by University of Southampton

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