Scientists develop plastic flexible magnetic memory device

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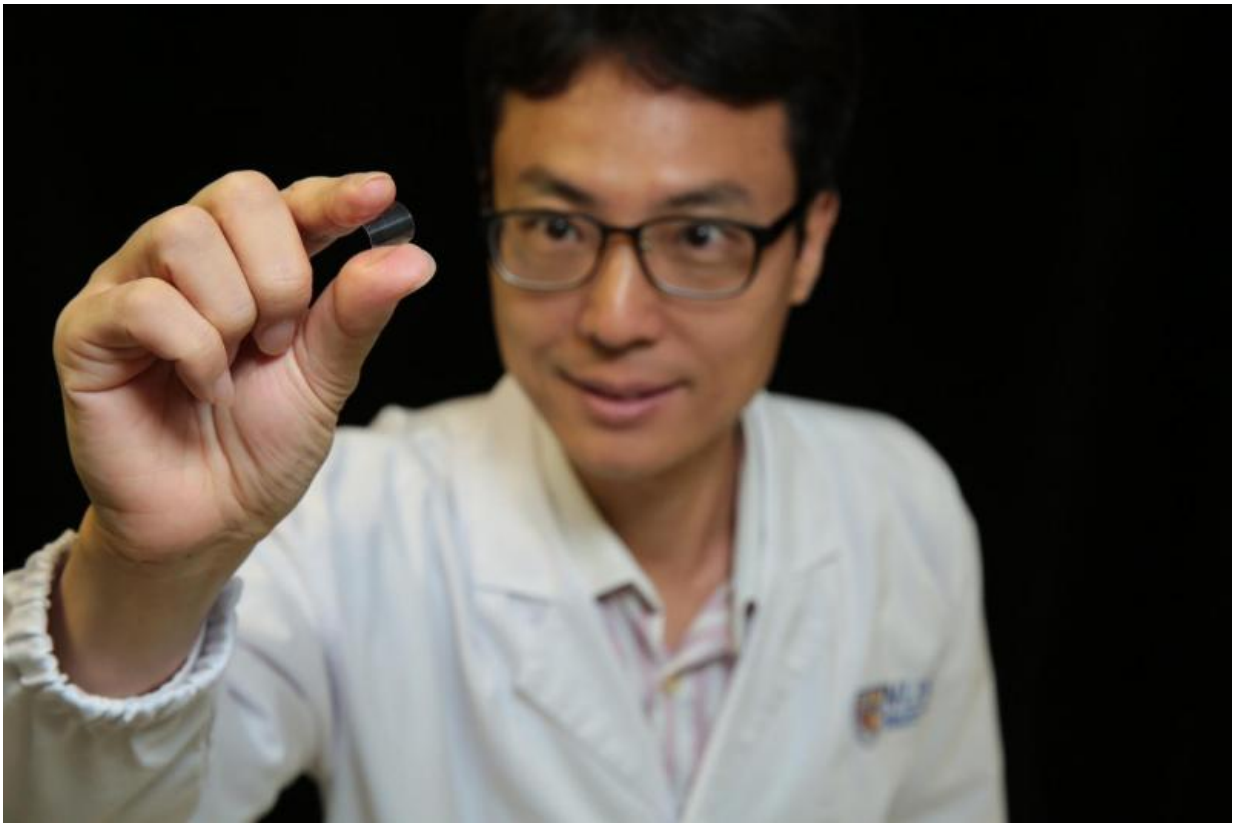

Associate Professor Yang Hyunsoo from the National University of Singapore, who led a research team to successfully embed a powerful magnetic memory chip on a plastic material, demonstrating the flexibility of the memory chip. Credit: National University of Singapore

Associate Professor Yang Hyunsoo from the National University of

Singapore led a research team to successfully embed a powerful magnetic memory chip on a flexible plastic material. This malleable memory chip hails a breakthrough in the flexible electronics revolution, and brings researchers a step closer towards making flexible, wearable electronics a reality in the near future.

It looks like a small piece of transparent film with tiny engravings on it, and is flexible enough to be bent into a tube. Yet, this piece of "smart" plastic demonstrates excellent performance in terms of data storage and processing capabilities. This novel invention, developed by researchers from the National University of Singapore (NUS), hails a breakthrough in the flexible electronics revolution, and brings researchers a step closer towards making flexible, wearable electronics a reality in the near future.

The technological advancement is achieved in collaboration with researchers from Yonsei University, Ghent University and Singapore's Institute of Materials Research and Engineering. The research team has successfully embedded a powerful magnetic memory chip on a flexible plastic material, and this malleable memory chip will be a critical component for the design and development of flexible and lightweight devices. Such devices have great potential in applications such as automotive, healthcare electronics, industrial motor control and robotics, industrial power and energy management, as well as military and avionics systems.

The research team, led by Associate Professor Yang Hyunsoo of the Department of Electrical and Computer Engineering at the NUS Faculty of Engineering, published their findings in the journal *Advanced Materials* on 6 July 2016.

Flexible, high-performance memory devices a key enabler for flexible electronics

Flexible electronics has become the subject of active research in recent times. In particular, flexible magnetic memory devices have attracted a lot of attention as they are the fundamental component required for data storage and processing in wearable electronics and biomedical devices, which require various functions such as wireless communication, information storage and code processing.

Although a substantial amount of research has been conducted on different types of memory chips and materials, there are still significant challenges in fabricating high performance memory chips on soft substrates that are flexible, without sacrificing performance.

To address the current technological challenges, the research team, led by Assoc Prof Yang, developed a novel technique to implant a high-performance magnetic memory chip on a flexible plastic surface.

The novel device operates on magnetoresistive random access memory (MRAM), which uses a magnesium oxide (MgO)-based magnetic tunnel junction (MTJ) to store data. MRAM outperforms conventional random access memory (RAM) computer chips in many aspects, including the ability to retain data after a power supply is cut off, high processing speed, and low power consumption.

Novel technique to implant MRAM chip on a flexible plastic surface

The research team first grew the MgO-based MTJ on a silicon surface, and then etched away the underlying silicon. Using a transfer printing approach, the team implanted the magnetic memory chip on a flexible plastic surface made of polyethylene terephthalate while controlling the amount of strain caused by placing the memory chip on the plastic surface.

Assoc Prof Yang said, "Our experiments showed that our device's tunneling magnetoresistance could reach up to 300 per cent – it's like a car having extraordinary levels of horsepower. We have also managed to achieve improved abruptness of switching. With all these enhanced features, the flexible magnetic chip is able to transfer data faster."

Commenting on the significance of the breakthrough, Assoc Prof Yang said, "Flexible electronics will become the norm in the near future, and all new electronic components should be compatible with flexible electronics. We are the first team to fabricate magnetic memory on a flexible surface, and this significant milestone gives us the impetus to further enhance the performance of flexible memory devices and contribute towards the flexible electronics revolution."

Assoc Prof Yang and his team were recently granted United States and South Korea patents for their technology. They are conducting experiments to improve the magnetoresistance of the device by fine-tuning the level of strain in its magnetic structure, and they are also planning to apply their technique in various other electronic components. The team is also interested to work with industry partners to explore further applications of this novel technology.

More information: Li Ming Loong et al. Flexible MgO Barrier Magnetic Tunnel Junctions, *Advanced Materials* (2016). DOI: 10.1002/adma.201600062

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