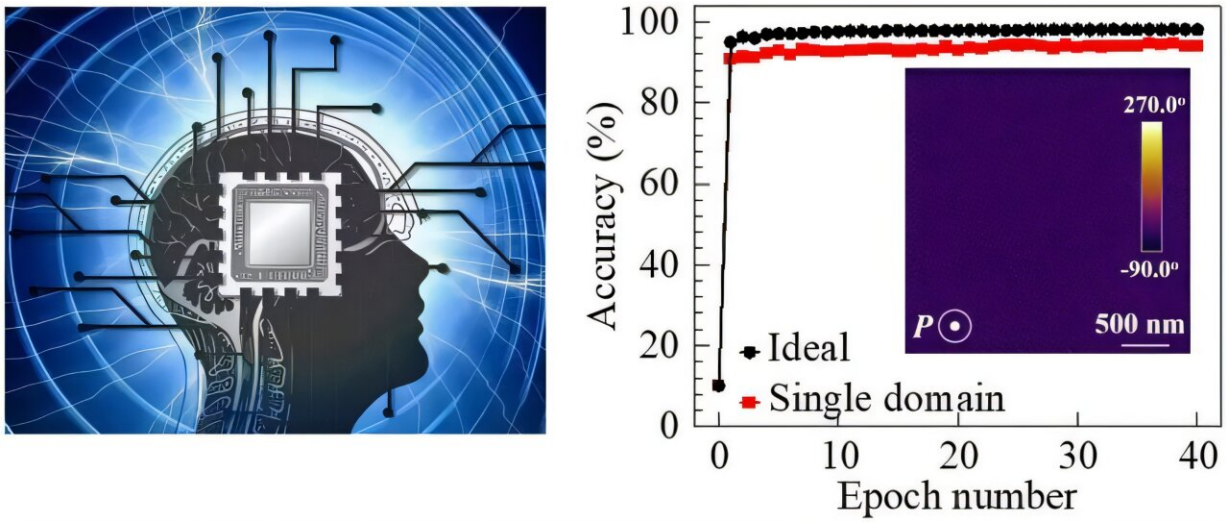
Researchers achieve single-domain ferroelectric thin films through simple temperature control

March 10 2025, by Zhang Nannan



The conception of neuromorphic computing (left from Baidu) and pattern recognition accuracy of a single domain ferroelectric synapse. Credit: IMR

A research team led by Prof. Hu Weijin from the Institute of Metal Research (IMR) of the Chinese Academy of Sciences has discovered that single-domain ferroelectric thin films can be efficiently achieved by simply elevating the growth temperature.

Their findings, published in *Advanced Functional Materials*, offer a

straightforward alternative to conventional complex fabrication methods, with significant implications for ferroelectric device performance.

Ferroelectric materials naturally form polydomain structures to minimize electrostatic energy. Nevertheless, single-domain thin films can be achieved through precise control of interfacial atomic layers or strain gradients. The quest for a simple method to obtain a single-domain state and its impact on ferroelectric device performance are of great interest.

In this study, the researchers demonstrated that the ferroelectric single-domain, compared to a polydomain, can significantly improve the performance of ferroelectric synaptic devices. To explore this, they utilized $BaTiO_3$ (BTO) ferroelectric films deposited onto $La_{0.67}Sr_{0.33}MnO_3$ metallic layers at temperatures ranging from 700°C to 850°C using pulsed laser deposition, a technique well-suited for producing high-quality single-crystalline oxide films.

The researchers discovered that when LSMO was grown at temperatures above 800°C, the resulting BTO films exhibited a single-domain configuration. They observed that Sr ions tended to diffuse towards the interface, creating a positively charged surface that aligned the polarizations uniformly across the film.

"This approach is much simpler compared to other methods such as atomic layer engineering, which typically requires complex surface treatments and precise growth control," said Hu. "It holds the potential for large-scale production of single-domain films beyond the current 5 mm × 5 mm size, possibly through industrial processes like spin coating."

Large-scale single-domain films could not only enhance the ferroelectric synapse performance used for neuromorphic computing, but also have applications in many other fields, including optoelectronics and catalysis.

More information: Xiaoqi Li et al, Interface Element Accumulation-Induced Single Ferroelectric Domain for High-Performance Neuromorphic Synapse, *Advanced Functional Materials* (2025). DOI: 10.1002/adfm.202423225