Physicists find evidence of previously unseen transition in ferroelectrics

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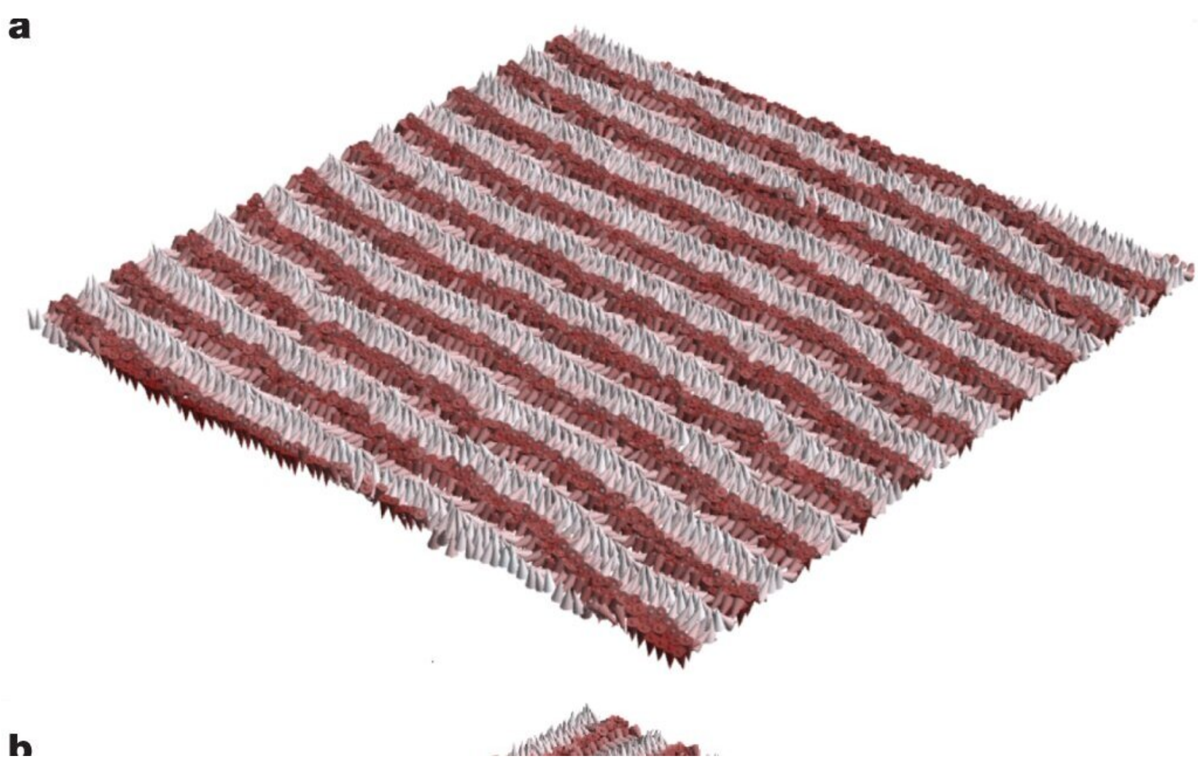

a, Ground-state dipolar configuration (parallel stripes) in the middle layer of an 80 × 80 × 5 unit-cell film of Pb(Zr0.4Ti0.6)O3 as obtained upon slowly decreasing the temperature from 650 K to 10 K. b, Dipolar configuration of the maze or labyrinthine pattern as obtained upon abruptly cooling the system from 650 K to 10 K. Grey (red) dipoles are oriented along the [001] ([001¯])([001¯]) pseudo-cubic direction. Credit: *Nature* (2020). DOI: 10.1038/s41586-019-1845-4

In a recent study, University of Arkansas physics researchers found evidence of an inverse transition in ferroelectric ultrathin films, which could lead to advances in development of data storage, microelectronics and sensors.

"We found that a disordered labyrinthine phase transforms into the more ordered parallel-stripe structure upon raising the temperature," said Yousra Nahas, first author of the study titled "Inverse Transition of Labyrinthine Domain Patterns in Ferroelectric Thin Films," published in the journal *Nature*. Former and present U of A physics researchers Sergei Prokhorenko, Bin Xu, Sergey Prosandeev, and Distinguished Professor Laurent Bellaiche, along with colleagues in France, also contributed to the study.

Proposed a century ago, these types of transitions seem to contradict the fundamental law that disorder increases with temperature. They have been found in other systems such as superconductors, proteins, liquid crystals and metallic alloys. But they had not been found in ferroelectric materials, which are of interest to scientists because they possess spontaneous electrical polarization that can be reversed by the application of an electric field.

The University of Arkansas researchers were able to model the transitions using the Arkansas High Performance Computing Center, which is funded in part by the Arkansas Economic Development Commission. Researchers in France demonstrated the model's predictions through laboratory experiments.

"These findings may be put at use to leap beyond current technologies by enabling fundamentally new design principles and topologically enhanced functionalities within ferroelectric films," said Nahas.

More information: Y. Nahas et al, Inverse transition of labyrinthine domain patterns in ferroelectric thin films, *Nature* (2020). DOI: 10.1038/s41586-019-1845-4

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