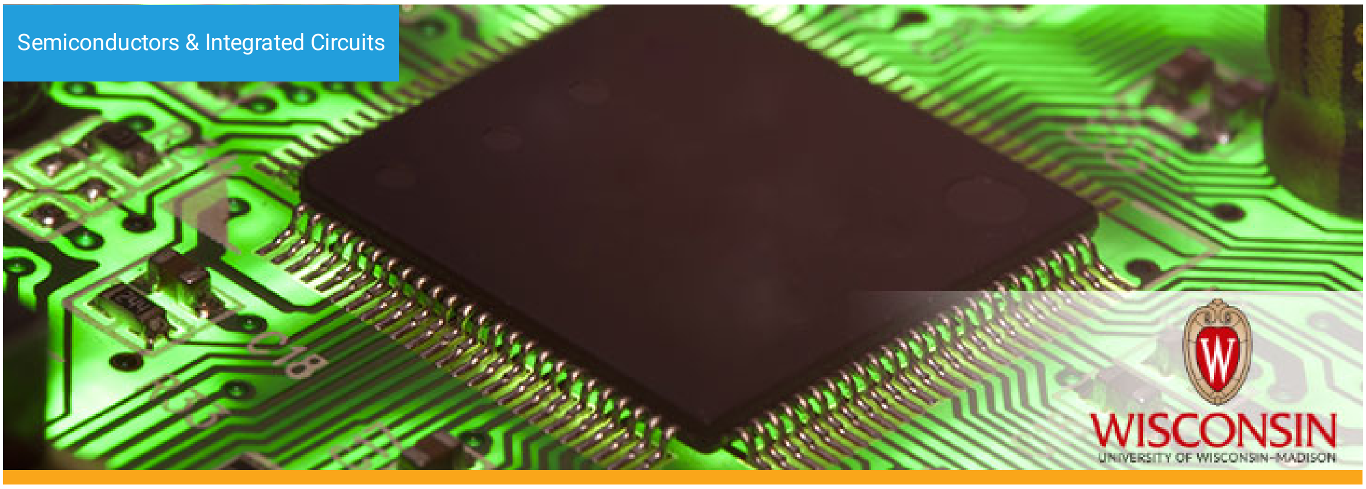

Ferroelectric Thin Films for Improving Memory Technology

View U.S. Patent No. 7,754,351 in PDF format.

WARF: P08062US

Inventors: Chang-Beom Eom, Ho Won Jang

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing $BiFeO_3$ thin films with enhanced ferroelectric properties that can be exploited in memory devices.

Overview

The semiconductor industry constantly is seeking new methods to improve memory speed and efficiency that are compatible with large-scale fabrication processes and environmentally-friendly.

Currently, Flash memory is the most commonly used type of memory in personal electronic devices. It has a higher storage density and is less expensive to manufacture than previous technologies because more components are packaged into the same space on a single chip. However, reducing component size can eliminate the ferroelectric properties of some materials so they are no longer usable. In addition, Flash memory only can be used for a limited number of write-erase cycles.

Ferroelectric memory (FeRAM) is one of a growing number of alternative non-volatile memory technologies offering similar functionality as Flash memory. FeRAM's advantages over Flash include lower power usage, faster write speeds and a much greater maximum number of write-erase cycles.

To make them more competitive with Flash memory, FeRAM devices have been improved to exploit the properties of $BiFeO_3$ in a thin film process. In comparison to other FeRAM materials, such as $Pb(Zr,Ti)O_3$ and $SrBi_2Ta_2O_9$, $BiFeO_3$ is lead free and poses no environmental risks or health concerns.

However, strain control is important in the production of non-volatile FeRAM. Current fabrication methods yield heterogeneous $BiFeO_3$ layers that experience varying degrees of strain, especially when undergoing thermal changes. This undesirable strain hinders the ferroelectric properties of the $BiFeO_3$ films and results in other unwanted effects. Methods of controlling strain are needed before $BiFeO_3$ films can be used effectively in FeRAM memory storage devices and other applications.

The Invention

UW-Madison researchers have developed a method for fabricating and transferring $BiFeO_3$ thin films onto a variety of substrates, thereby allowing limitless strain control. The $BiFeO_3$ layer can be epitaxially grown over a variety of materials, called perovskite, with the same type of crystal structure as calcium titanium oxide.

The perovskite layer functions as a buffer to protect the thin film during the chemical release process. Additionally, it improves the epitaxial growth of strain-free $BiFeO_3$ layers on different sacrificial substrates. Once released from their original sacrificial substrates, the free-standing $BiFeO_3$ perovskite heterostructures may be transferred onto a variety of host substrates to exhibit improved ferroelectric characteristics that include increased remnant polarization, reduced coercive field, reduced leakage current, and/or reduced fatigue.

This new fabrication method expands the prospect of fine tuning $BiFeO_3$ thin film characteristics to advance memory technology.

Applications

- Memory modules, such as hard drives and FeRAM
- Solar cells
- Radio frequency (RF) tags
- Displays
- Electro-optic modulators

Key Benefits

- Can be transferred to a variety of substrates (i.e., plastic, metal, glass, etc.)
- Offers advantages of strain-controlled films, which exhibit increased remnant polarization, reduced coercive field, reduced leakage current, and/or reduced fatigue
- Offers advantages of $BiFeO_3$ thin films, which produce the highest remnant polarization and lowest coercive field when compared to other ferroelectrics
- Provides lead-free and environmentally friendly ferroelectric films that are compatible with large-scale fabrication processes
- Provides improved features compared to Flash-based memory, including lower power usage, faster write speeds and a much greater maximum number of write-erase cycles

Additional Information

For More Information About the Inventors

- Chang-Beom Eom

Tech Fields

- Semiconductors & Integrated Circuits : Design & fabrication

For current licensing status, please contact Michael Carey at mcarey@warf.org or 608-960-9867