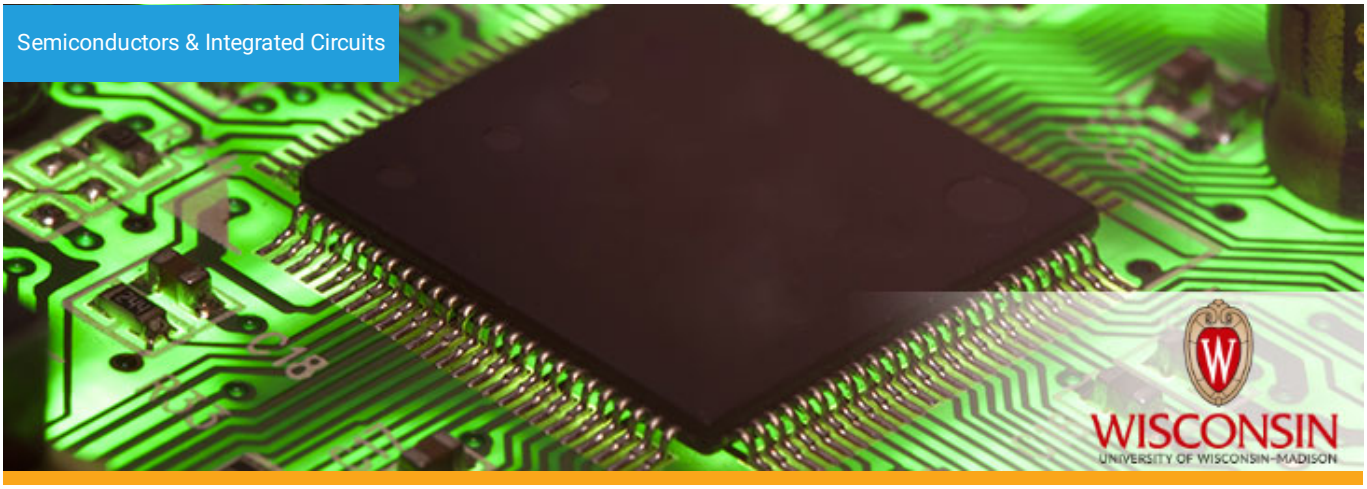
Semiconductors & Integrated Circuits



Strain-Engineered Ferroelectric Thin Films

View U.S. Patent No. 7,449,738 in PDF format.

WARF: P05036US

Inventors: Chang-Beom Eom, Kyoung-Jin Choi, Darrell Schlom, Long-Qing Chen

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing thin films that have been strain-engineered to greatly enhance their ferroelectric properties for FeRAM and related applications.

Overview

Significant efforts are currently underway to create ferroelectric memory (FeRAM) devices from the materials $Pb(Zr,Ti)O_3$ and $SrBi_2Ta_2O_9$. The main disadvantages of these materials are the volatility of lead and bismuth, which makes their incorporation into semiconductor fabs difficult, and the serious environmental and health concerns posed by lead.

The Invention

As an alternative to these materials, UW-Madison researchers have developed thin films that have been strain-engineered to greatly enhance their ferroelectric properties for FeRAM and related applications. The invention exploits the fact that enormous strain can develop in a thin film when one material is deposited on another due to factors such as mismatch between the materials' crystal lattice parameters or thermal expansion between the film and the underlying substrate. The end result is that a thin film under strain will exhibit dramatically different properties than the corresponding unstrained, bulk material.

The researchers showed that by inducing a biaxial compressive strain in a thin film of barium titanate ($BaTiO_3$), they could raise the film's ferroelectric transition temperature (T_c) by nearly 500 K and its remnant polarization (P_r) by at least 250 percent over single crystals of $BaTiO_3$. Both a high T_c and a high P_r are needed for FeRAM and electro-optic devices.

Applications

- FeRAM
- Electro-optic modulators
- Other ferroelectric devices

Key Benefits

- Dramatically increases the ferroelectric transition temperature (T_c) and remnant polarization (P_r) of barium titanate ($BaTiO_3$), making it suitable for use in FeRAM, electro-optic modulators and related ferroelectric devices
- These ferroelectric films are lead-free and environmentally benign.
- Unlike lead- and bismuth-containing materials, $BaTiO_3$ is compatible with semiconductor fabs and easy to integrate on silicon.

Additional Information

For More Information About the Inventors

- Chang-Beom Eom

Publications

- Choi K.J., Biegalski M., Li Y.L., Sharan A., Schubert J., Uecker R., Reiche P., Chen Y.B., Pan X.Q., Gopalan V., Chen L.Q., Schlom D.G. and Eom C.B. 2004. Enhancement of Ferroelectricity in Strained $BaTiO_3$ Thin Films. Science 306, 1005-1009.

Tech Fields

- Semiconductors & Integrated Circuits : Components & materials

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