

Engineered for Automotive Applications
and Back-End-of-Line Integration

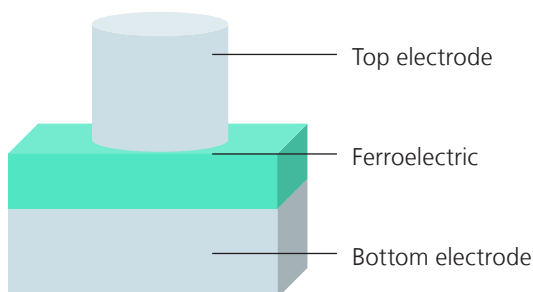
High-Performance Ferroelectric HfO₂ Stack

Fraunhofer IPMS offers advanced HfO₂-based ferroelectric stacks, ideal for applications in ferroelectric memories and smart sensors for the automotive industry.

Highlights

- High Temperature and Bias Resilience:**
Maintains low leakage under extreme conditions up to 175°C and 4 MV/cm.
- Enhanced Stability:**
Superior time- and temperature-dependent imprint performance over standard fluorite-structured films.
- Back-End-of-Line Compatibility:**
Seamlessly integrates with existing manufacturing processes for automotive applications.

Technical Specifications:



- Material Composition: HfO₂-based ferroelectric material
- Thickness: 10 nm
- Operating Voltage Range: 2.5V – 3.0V
- Operation Temperature Range: ≤ 175°C
- Polarization: $2P_r \geq 23 \mu\text{C}/\text{cm}^2$
- Endurance: up to 10⁶. ($T_{\text{prg}} = 0.1 \text{ ms}$)

Back-End-of-Line Integration:

- Functionalization Temperature: ≥ 400°C
- Annealing duration ≥ 60s

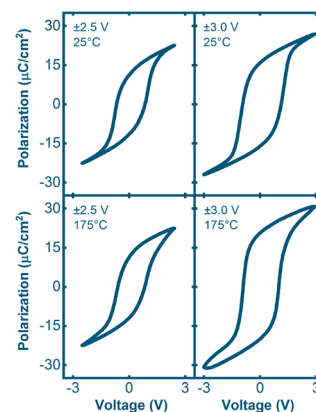
Polarization Characteristics

Measurement Conditions

Voltage range for PV plot	± 2.5 V ... ± 3.0 V
Frequency of DHM measurement	1 kHz
Number of wake-up cycles for PV plot	10 ⁴
Frequency of wake-up cycling for PV plot	10 kHz

Figures of Merit

2.5 MV/cm	@25 °C	@175 °C
Remanent polarization $2P_r$	23 $\mu\text{C}/\text{cm}^2$	24 $\mu\text{C}/\text{cm}^2$
Coercive field $2E_c$	1.5 MV/cm	1.5 MV/cm
3.0 MV/cm	@25 °C	@175 °C
Remanent polarization $2P_r$	32 $\mu\text{C}/\text{cm}^2$	40 $\mu\text{C}/\text{cm}^2$
Coercive field $2E_c$:	2.0 MV/cm	2.0 MV/cm



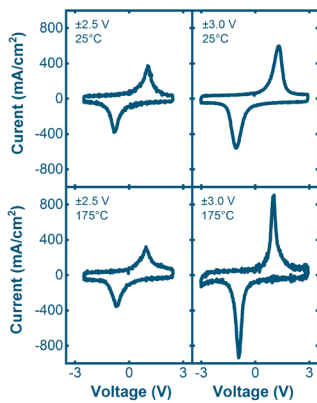
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Displacement and Leakage Current Characteristics



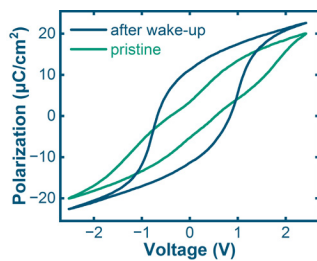
Measurement Conditions

Voltage range for JV plot	$\pm 2.5 \text{ V} \dots \pm 3.0 \text{ V}$
Frequency of DHM measurement	1 kHz
Number of wake-up cycles for PV plot	10^4
Frequency of wake-up cycling for PV plot	10 kHz

Figures of Merit

2.5 MV/cm	@25 °C	@175 °C
Max. current density at FE switching	350 mA/cm ²	350 mA/cm ²
Coercive field $2E_c$	1.5 MV/cm	1.5 MV/cm
3.0 MV/cm	@25 °C	@175 °C
Max. current density at FE switching	600 mA/cm ²	900 mA/cm ²

Wake-Up Characteristics



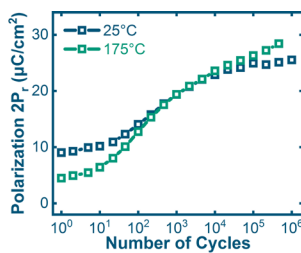
Measurement Conditions

DHM frequency	1 kHz
FM frequency	10 kHz
Voltage range	$\pm 2.5 \text{ V}$

Figures of Merit

Number of field cycles needed for wake-up	5×10^3
$2P_r$ (virgin)/ $2P_r$ (cycled)	27 %
Pre-cycled P_r/P_s	0.16
Post-cycled P_r/P_s	0.52

Endurance Characteristics



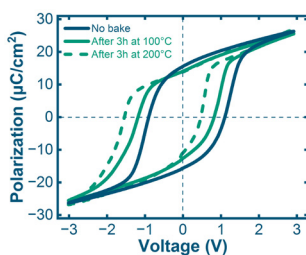
Measurement Conditions

FM frequency (pulse duration)	10 kHz (0.1 ms)
Pulse-Amplitude	$\pm 2.5 \text{ V}$

Figures of Merit

2.5 MV/cm	@25 °C	@175 °C
Number of field cycles to breakdown	10^6	4.6×10^5

Imprint



Measurement Conditions

DHM frequency	1 kHz
Voltage range	$\pm 3.0 \text{ V}$

Figures of Merit

Imprint after 3 h; 100 °C	0.3 V
Imprint after 3 h; 200 °C	0.6 V

Need Customized Ferroelectric Solutions for Your Automotive Applications?

We offer customization to meet your specific requirements and ensure optimal performance. Our ferroelectric stack can be tested within your platform or ours to verify compatibility with your needs.

Partner with Fraunhofer IPMS (Center Nanoelectronic Technologies) to elevate your automotive applications with our innovative ferroelectric technology. Contact us today to discuss your requirements and arrange a testing session.