

Abstract

# Hafnium Zirconium Oxide Thin Films for CMOS Compatible Pyroelectric Infrared Sensors <sup>†</sup>

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**Abstract:** Pyroelectric infrared sensors are often based on lead-containing materials, which are harmful to the environment and subject of governmental restrictions. Ferroelectric  $\text{Hf}_{1-x}\text{Zr}_x\text{O}_2$  thin films offer an environmentally friendly alternative. Additionally, CMOS integration allows for integrated sensor circuits, allowing for scalable and cost-effective applications. In this work, we demonstrate the deposition of pyroelectric thin films on area-enhanced structured substrates via thermal atomic layer deposition. Scanning electron microscopy indicates a conformal deposition of the pyroelectric film in the holes with a diameter of 500 nm and a depth of 8  $\mu\text{m}$ . By using TiN electrodes and photolithography, capacitor structures are formed, which are contacted via the electrically conductive substrate. Ferroelectric hysteresis measurements indicate sizable remanent polarization of up to 331  $\mu\text{C cm}^{-2}$ , which corresponds to an area increase of up to 15 by the nanostructured substrate. For pyroelectric analysis, a sinusoidal temperature oscillation is applied to the sample. Simultaneously, the pyroelectric current is monitored. By assessing the phase of the measured current profile, the pyroelectric origin of the signal is confirmed. The devices show sizable pyroelectric coefficients of  $-475 \mu\text{C m}^{-2} \text{K}^{-1}$ , which is larger than that of lead zirconate titanate (PZT). Based on the experimental evidence, we propose  $\text{Hf}_{1-x}\text{Zr}_x\text{O}_2$  as a promising material for future pyroelectric applications.

**Keywords:** pyroelectric; ferroelectric; infrared; sensor; CMOS