engineering proceedings

Abstract

Hafnium Zirconium Oxide Thin Films for CMOS Compatible Pyroelectric Infrared Sensors †

Clemens Mart, Malte Czernohorsky, Kati Kühnel and Wenke Weinreich *

Fraunhofer Institute for Photonic Microsystems, 01099 Dresden, Germany; Clemens.mart@gmail.com (C.M.); Malte.czernohorsky@ipms.fraunhofer.de (M.C.); Kati.kuehnel@ipms.fraunhofer.de (K.K.)

* Correspondence: wenke.weinreich@ipms.fraunhofer.de

† Presented at the 8th International Symposium on Sensor Science, 17–28 May 2021; Available Online: https://i3s2021dresden.sciforum.net/.

Abstract: Pyroelectric infrared sensors are often based on lead-containing materials, which are harmful to the environment and subject to governmental restrictions. Ferroelectric $Hf_{1-x}Zr_xO_2$ thin films offer an environmentally friendly alternative. Additionally, CMOS integration allows for integrated sensor circuits, enabling 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 µm. By using TiN electrodes and photolithography, capacitor structures are formed, which are contacted via the electrically conductive substrate. Ferroelectric hysteresis measurements indicate a sizable remanent polarization of up to 331 µC 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 µC m^{-2} K^{-1}, which is larger than that of lead zirconate titanate (PZT). Based on the experimental evidence, we propose $Hf_{1-x}Zr_xO_2$ as a promising material for future pyroelectric applications.

Keywords: pyroelectric; ferroelectric; infrared; sensor; CMOS

Citation: Mart, C.; Czernohorsky, M.; Kühnel, K.; Weinreich, W. Hafnium Zirconium Oxide Thin Films for CMOS Compatible Pyroelectric Infrared Sensors. *Eng. Proc.* **2021**, *6*, 27. https://doi.org/10.3390/I3S2021Dresden-10138

Academic Editors: Gianaurelio Cuniberti and Larysa Baraban

Published: 17 May 2021

Supplementary Materials: The presentation file is available at https://www.mdpi.com/article/10.3390/I3S2021Dresden-10138/s1.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.