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Electronic Supporting Information

Combining Inverse and Conventional Pyroelectricity in Anti-Ferroelectric Thin Films for Energy Conversion

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PLZT thin film device fabrication

500 nm of SiO_2 was thermally grown on 150 nm silicon wafer. 30 nm of Ti was sputter deposited (Unaxis Clusterline 200) then oxidized at 750 °C under O_2 to yield TiO_2 that acts as a templated fo {111}- textured Pt bottom electrode which is also sputter deposited to a thickness of 100 nm. Chemical solution deposition using 2-methoxyethanol solvent was used to grow the PLZT thin films. A distilled solution of lead (II) acetate trihydrate was mixed with zirconium (IV) n-propoxide, tanthanum (III) iso-propoxide, and titanium (IV) isopropoxide in an appropriate ratio to achieve a 95:5 Zr:Ti cation ratio. The solution is spun on to the substrate at a speed of 2500 rpm and pyrolized at 350 °C for 2 min to remove a majority of the organic species. Following pyrolysis, the films were annealed (AG Associates Heatpulse 610 RTA) at 700 °C for 60s in an O_2 environment, resulting in a ~60 nm film, measured using ellipsometry. This process is repeated until the film measures 500 nm and confirmed crystalline using X-ray diffraction (Rigaku Miniflex 600 x-ray diffractometer). IrO_2 top electrodes are reactively sputtered (Unaxis Clusterline 200) at 30 °C in a 3:1 Ar:O_2 plasma from a Ir target to a thickness of 100 nm, measured using cross-section SEM (Zeiss Auriga scanning electron microscope). Top electrode structures are defined using photolithography and ion-milling (4wave 4W-PSIBE).

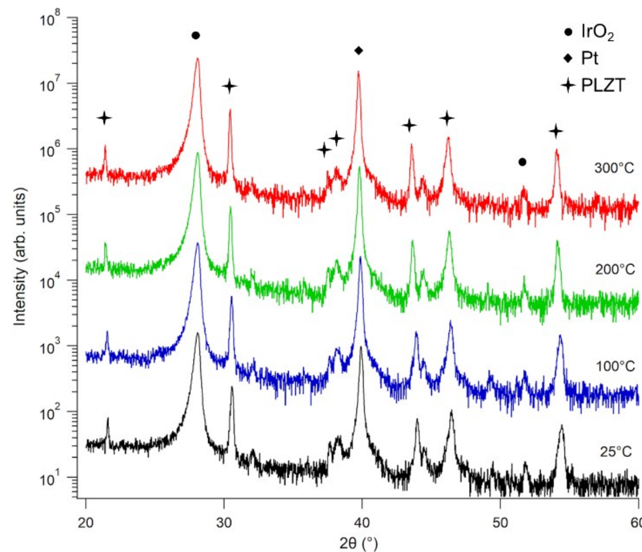

Fig. S1 *X-ray diffraction patterns for tested ($Pb_{0.995}La_{0.005}$)($Zr_{0.95}Ti_{0.05}O_3$) devices, including platinum bottom and IrO_2 top electrodes, from 25-300 °C .*

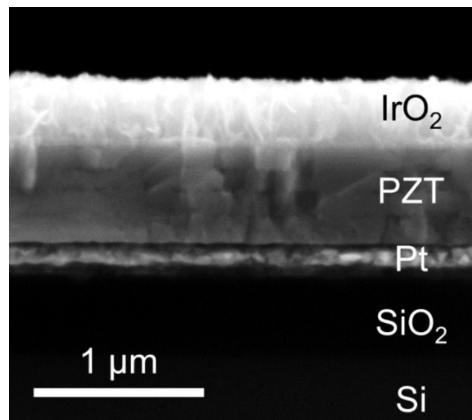

Fig. S2 *SEM cross section of tested PLZT devices.*

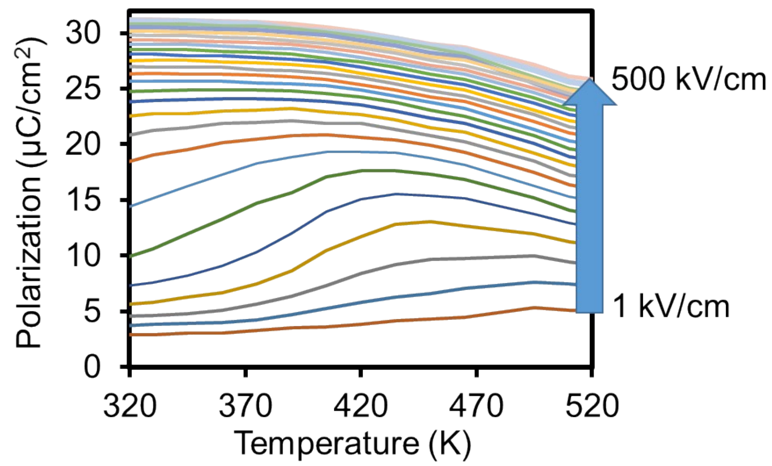

Fig. S3 Polarization relationship with temperature response at various applied electric fields. The data is extracted from isothermal hysteresis loops from -20 to 20 V, taken at temperatures from 320-520 K.

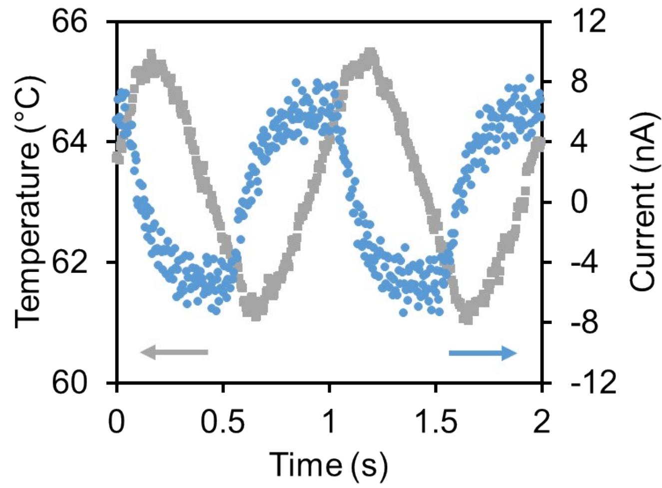

Fig. S4 Pyroelectric current measured on the AFE sample during periodic thermal excitation. Temperature is measured on lithographically-defined platinum wire co-located on chip.

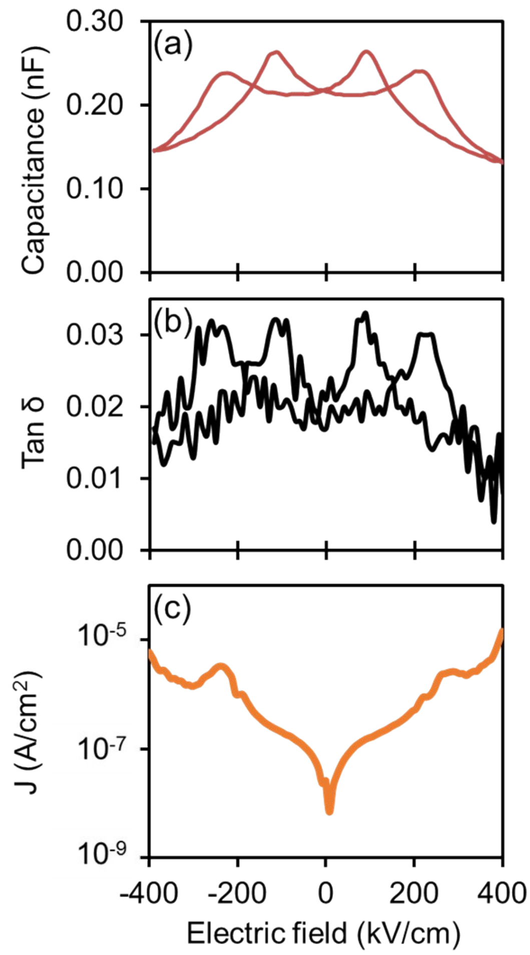

Fig. S5 (a) Capacitance ,(b) loss tangent measured at 10 kHz and (c) current density measurements taken from step-wise voltage increases and 4 s hold times.