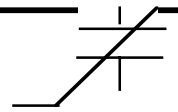
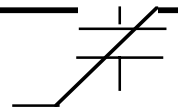


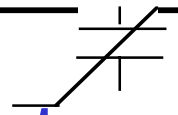
Pyroelectric Testing of a Radiant 4/20/80 PNZT Film

Joe T. Evans, Jr.
Radiant Technologies, Inc.
February 16, 2004



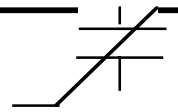
Description of Samples

- The bottom electrode was platinum deposited as a global layer on a prepared 100mm silicon wafer.
  - 5000Å thermal silicon dioxide
  - 400Å thermal titanium dioxide
  - 1500Å e-beam evaporated platinum
- 4000Å of 4% niobium doped 20/80 PZT was deposited by spin casting in four sequential layers.
- The top electrode consisted of 1000Å of evaporated platinum patterned using a lift-off process.



Pyroelectric Coefficient

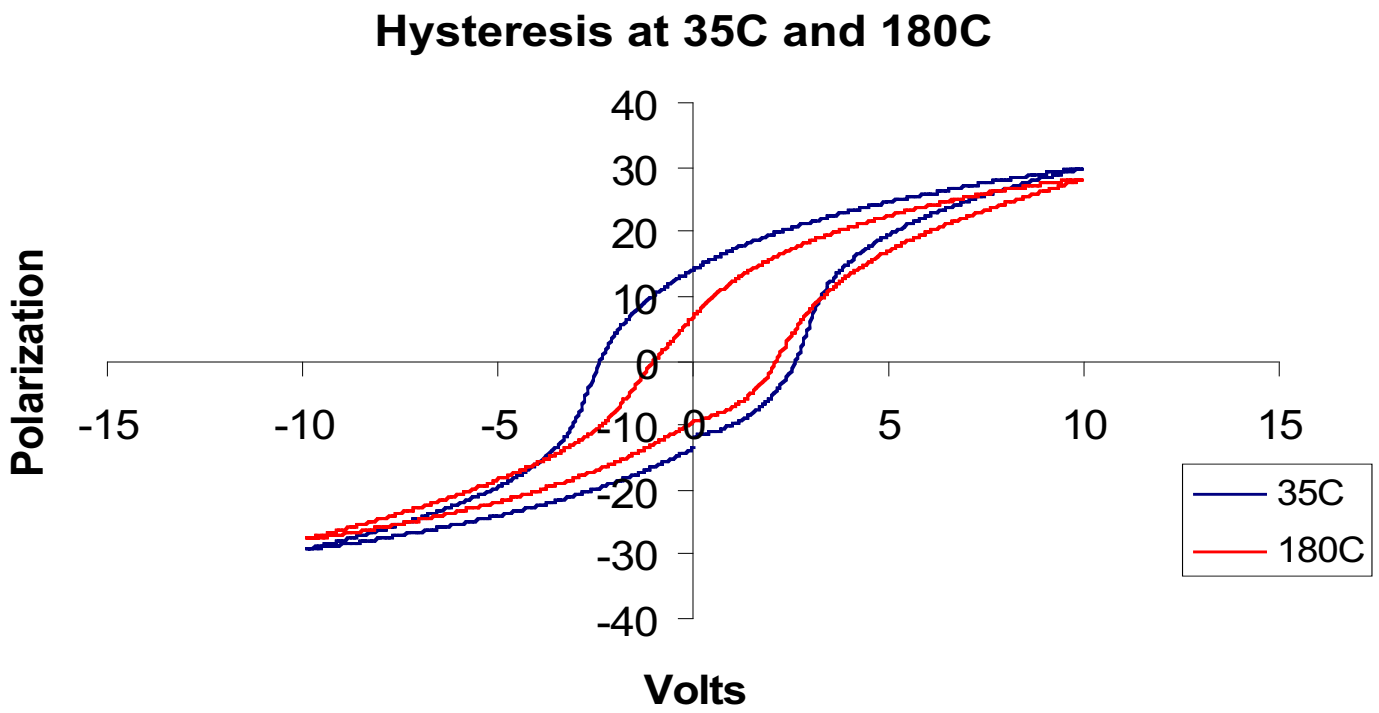
- The pyroelectric property is considered to be generated by the change in the domain polarization in response to a change in temperature. The change in polarization results in a current flow to or from the capacitor as the temperature changes.
- The traditional method of measuring the pyroelectric response is to monitor the current flow into or out of the capacitor as the temperature is ramped at a constant rate.
- Radiant has developed a technique, embodied in the CHAMBER task, whereby the remanent polarization is measured statically over a range of temperatures. The pyroelectric constant can then be calculated from the slope of the remanent polarization versus temperature.



Test Procedure

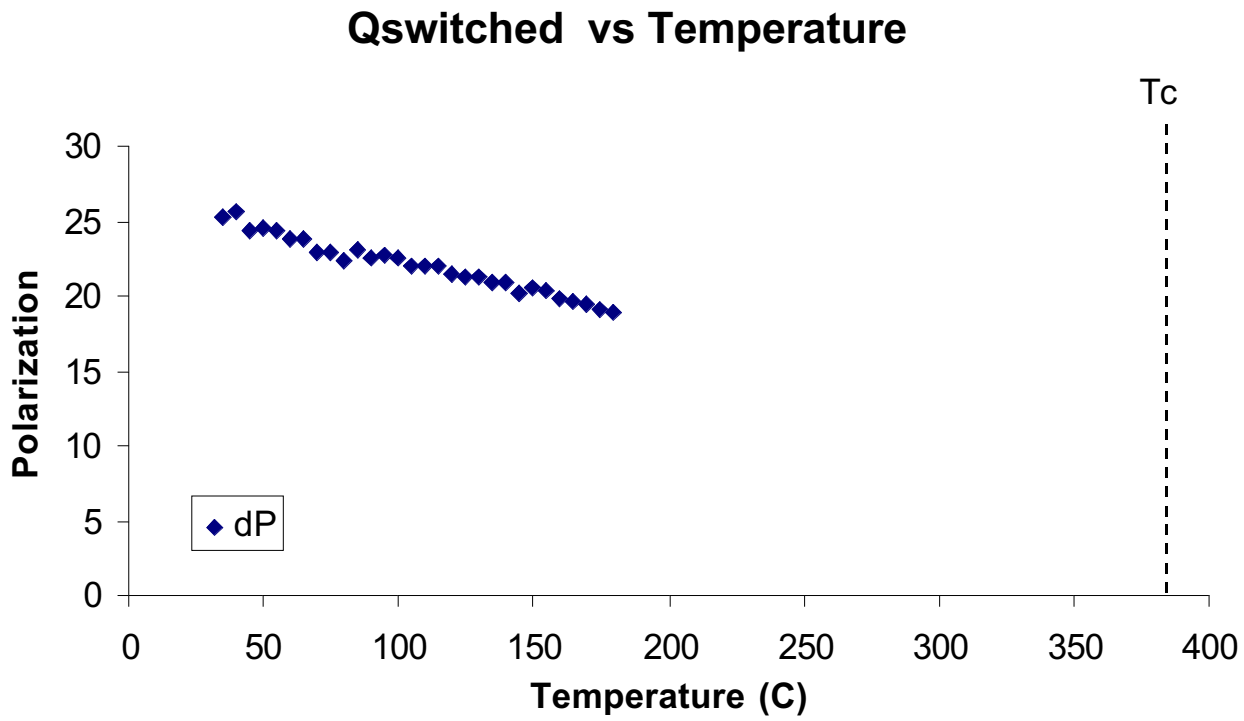
- The thin film sample was placed on a Signatone H-100 probe station with a programmable hot plate.
- CHAMBER was run in the manual mode whereby it informs the user to change the temperature and then waits for the user to signal that the temperature has stabilized at the requested value.
  - CHAMBER will also run automatically when connected to a GPIB or RS232 controlled hotplate or temperature chamber.
- CHAMBER was programmed to measure remanent polarization using the PUND test from 35°C to 180°C in increments of 5°C.
  - CHAMBER will also measure small signal capacitance.

Hysteresis Loop @ 35°C and 180°C



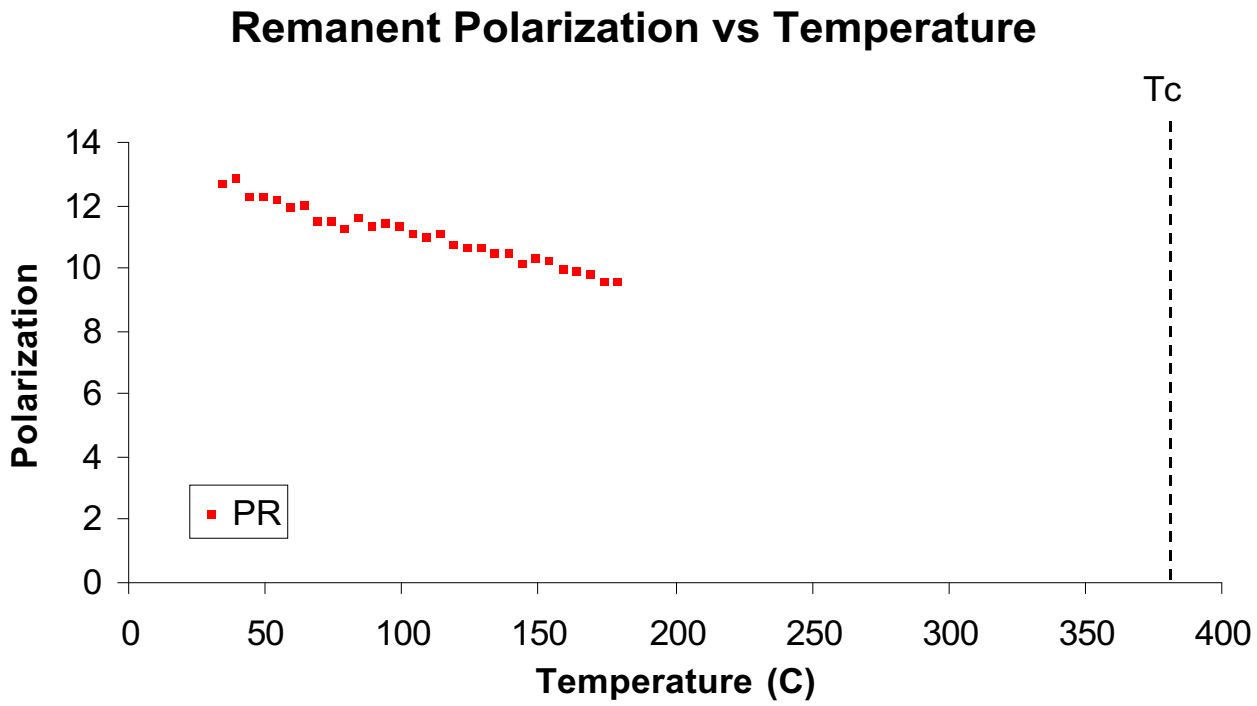
Hysteresis at 15V (375KV/cm) with a 1ms period at both 35°C and 180°C. As expected, the total polarization has not changed much but the remanent polarization has changed significantly.

Qswitched vs Temperature



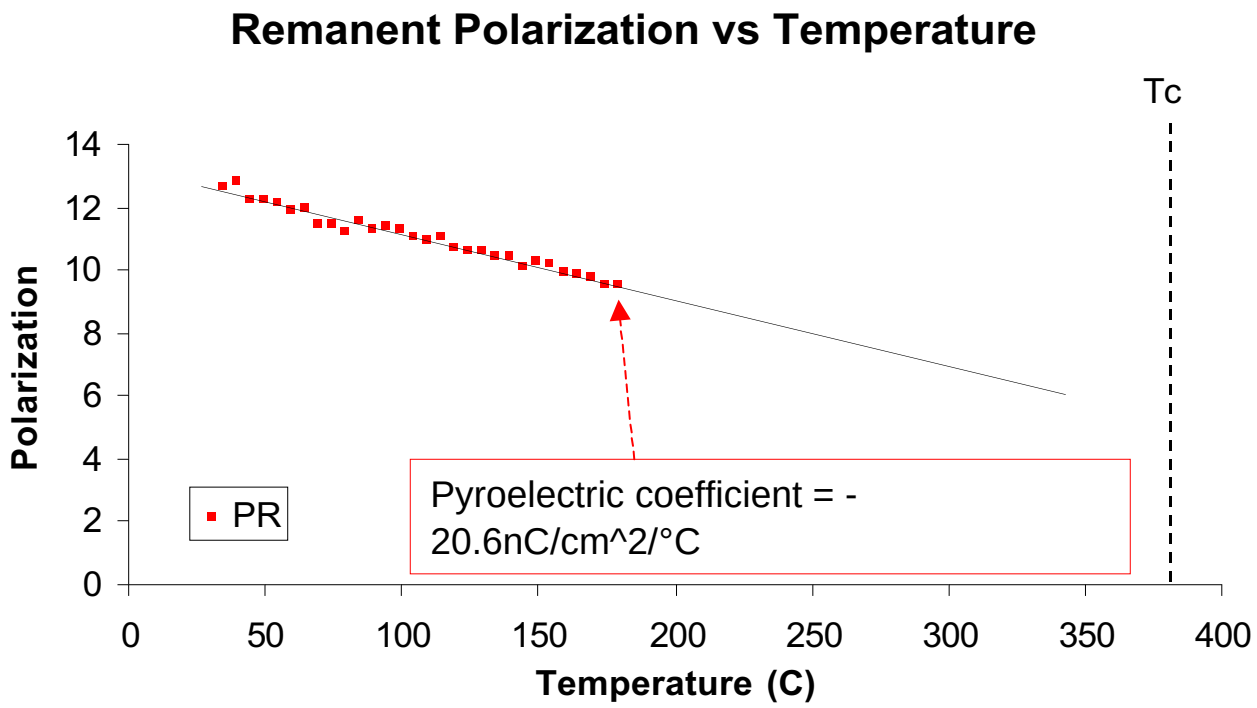
Qswitched is the difference between the switched and non-switched pulse of the PUND test. It is nominally twice the value of the remanent polarization.

Remanent Polarization vs Temperature

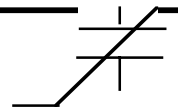


The Remanent Polarization is half the value of Qswitched.

The Pyroelectric Coefficient



The pyroelectric coefficient is the slope of the polarization loss. In this case, it is quite linear.



Conclusion

- Radiant measured the pyroelectric coefficient to be a negative 20.6nC/cm^2/°C for its 4/20/80 PNZT film on platinum electrodes.
  - The capacitor size was 1x10^{-4}cm^2. Absolute polarization change was 2.06pC/°C.
- The CHAMBER task allows automated collection of pyroelectric coefficient information on Radiant's Precision Testers.