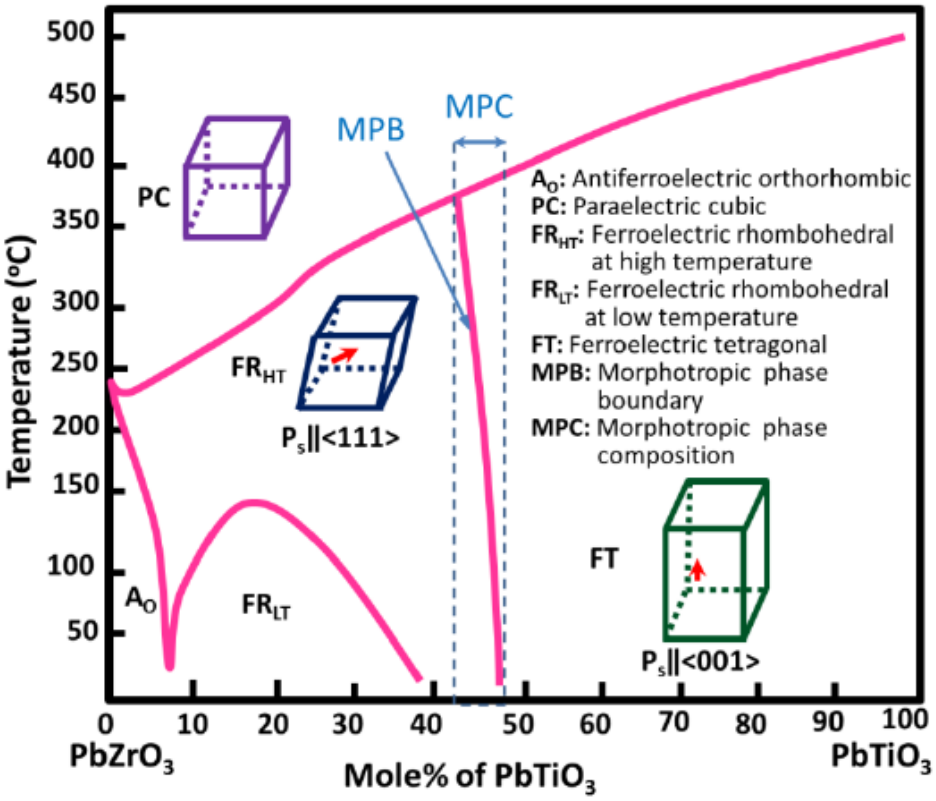
University of Babylon/ College of Materials Engineering
Department of Ceramic Engineering and Building Materials

Phase Transformations in Materials

- Structural phase transition
- Electronic phase transitions

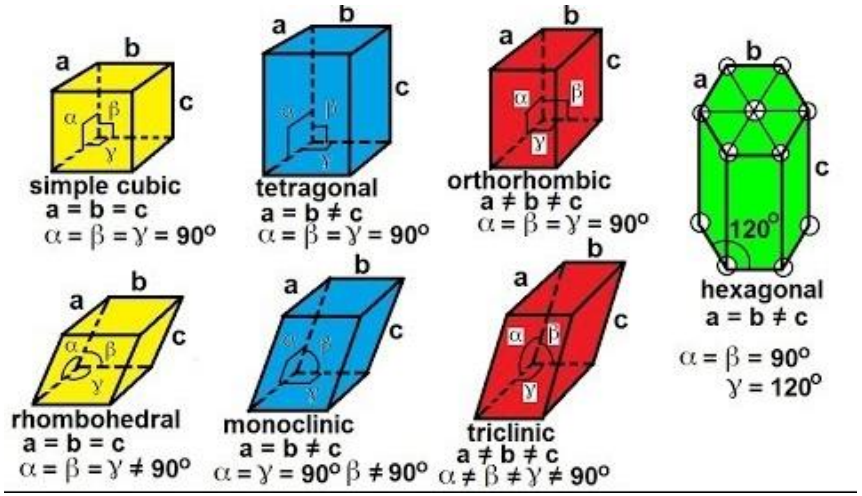
phase transition can be induced by:

1- Compositional induced phase transition
2- Electric field induced phase transition
3- Temperature induced phase transition
4- Pressure induced phase transition



phase transition can be detected by:

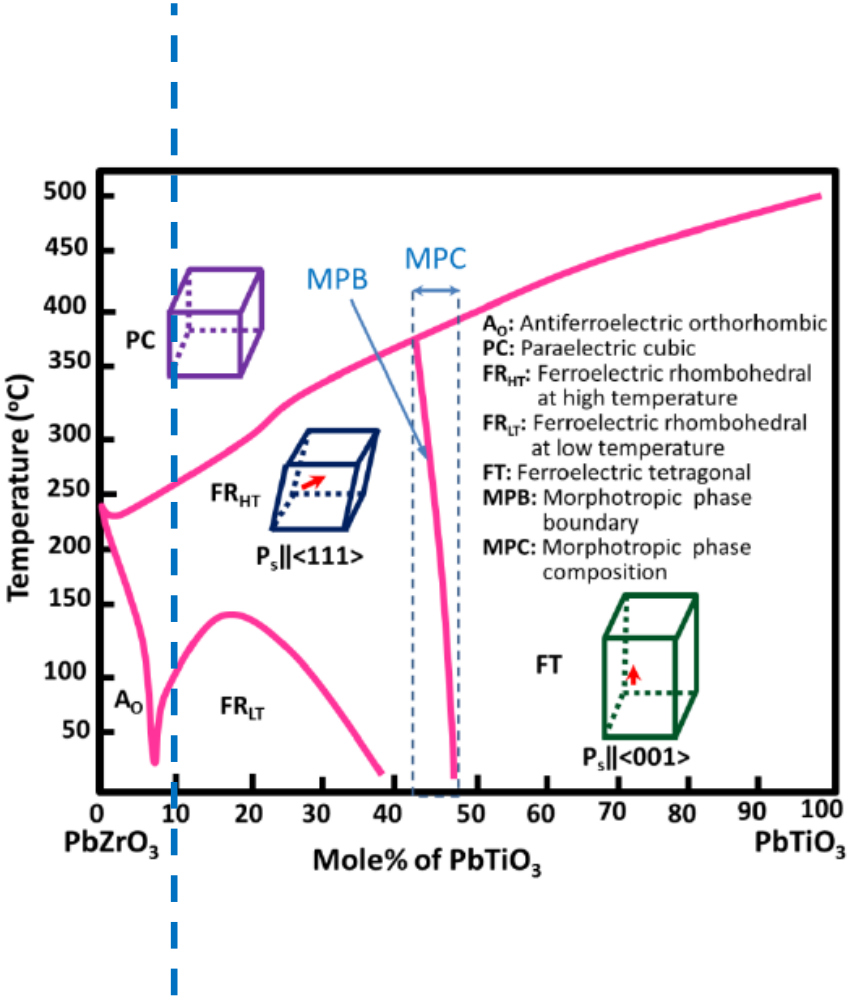
1- X-ray diffraction
2- Temperature dependence of relative permittivity (dielectric constant)
3- Polarization- electric field hysteresis loop



1- Compositional induced phase transition: X-ray diffraction

Effects of lanthanum modification on dielectric properties of $Pb(Zr_{0.90},Ti_{0.10})O_3$ ceramics: enhanced antiferroelectric stability

Abstract Lanthanum modified lead zirconate titanate ceramics with lanthanum content changing from 2 to 6 at% La and a Zr/Ti ratio of 90/10 (PLZT *x*/90/10) have been analyzed by using X-ray diffraction, dielectric response, differential scanning calorimetry, and ferroelectric hysteresis. An antiferroelectric state was found to be stabilized, whereas the long-range ferroelectric state was disrupted by lanthanum substitution on the lead sites. A ferroelectric state is shown to be stable over an antiferroelectric state for low lanthanum contents in a wide temperature range, where both phases coexist. With the increase of the lanthanum concentration, the long-range coherency of the ferroelectric state is suppressed, i.e., the temperature range of the ferroelectric state stability decreased, disappearing for $x > 3$ at% La.



- **perovskite crystal ABO_3.**
- ***Examples***

  $A^{+2}B^{+4}O_3$ ($Pb^{+2}Ti^{+4}O_3$)

1- Compositional induced phase transition: X-ray diffraction

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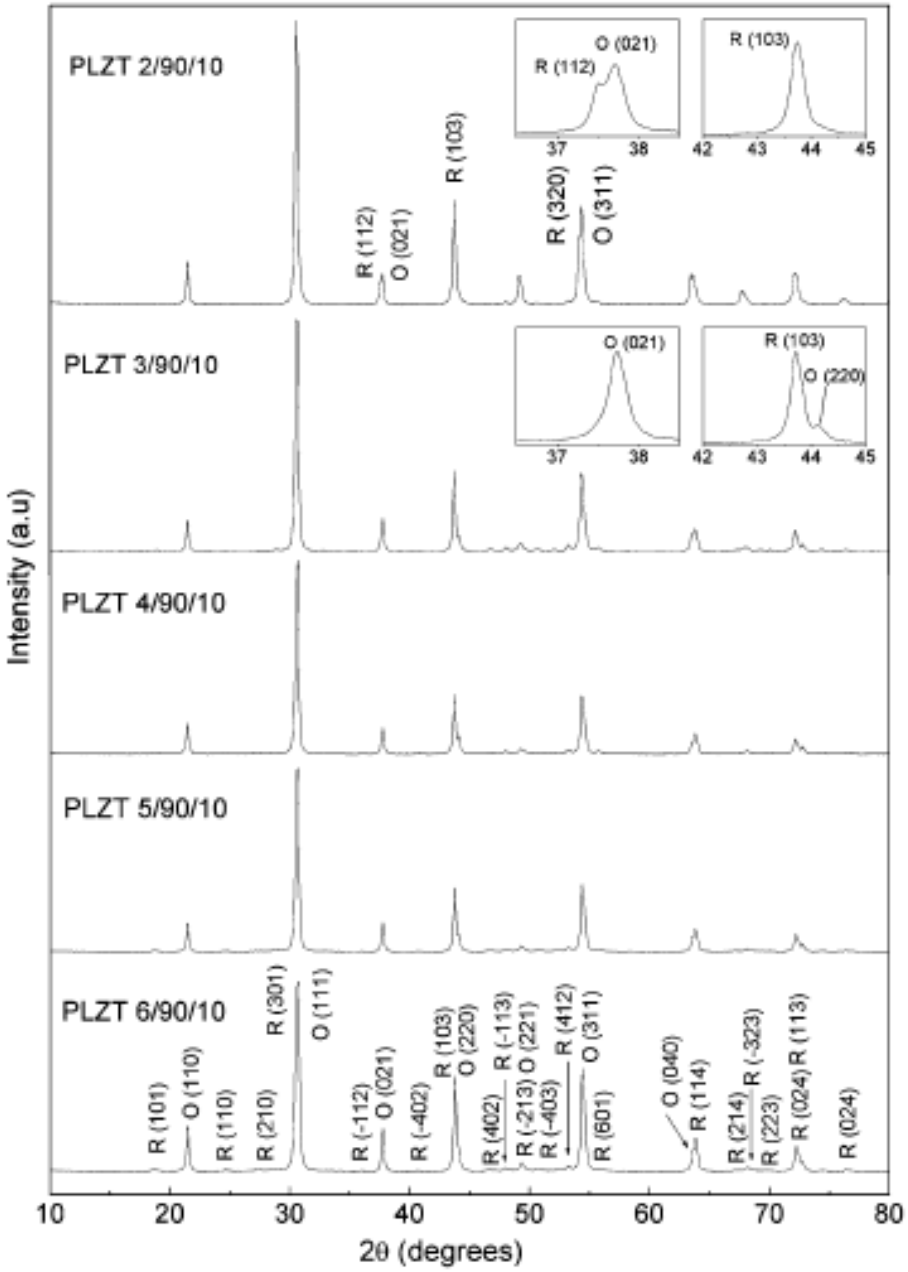

Fig. 1 X-ray diffraction pattern at room temperature for the PLZT *x*/90/10 studied compositions

1- Compositional induced phase transition: X-ray diffraction

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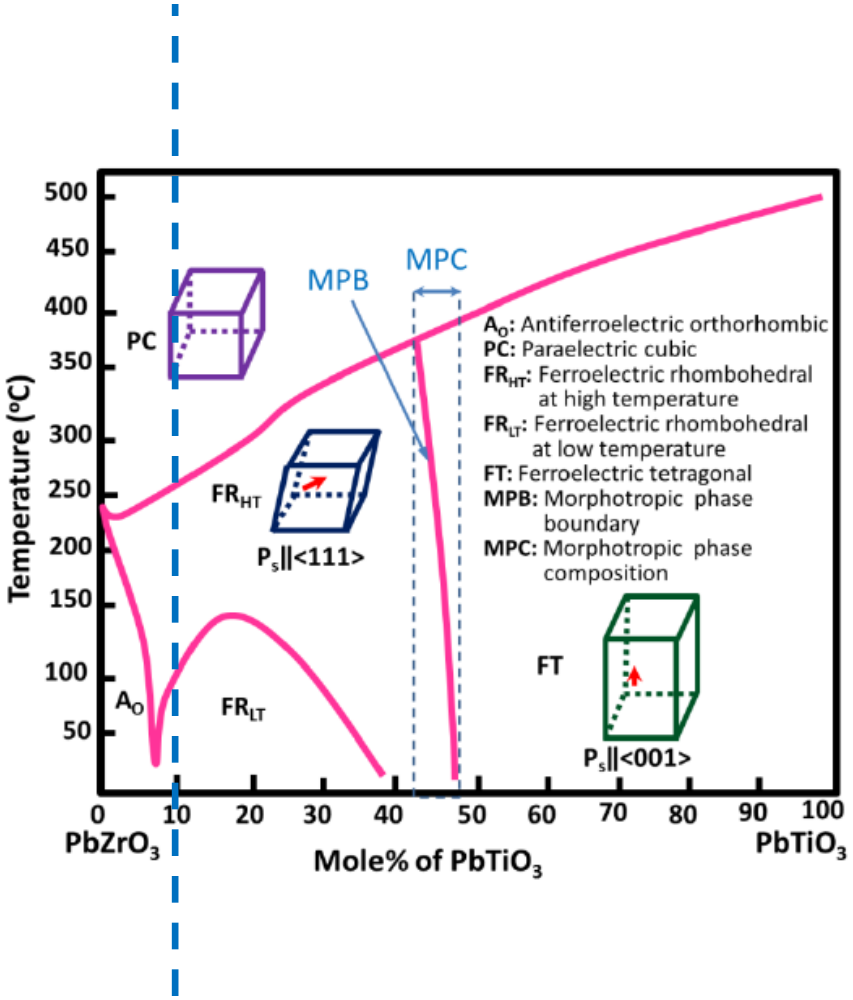

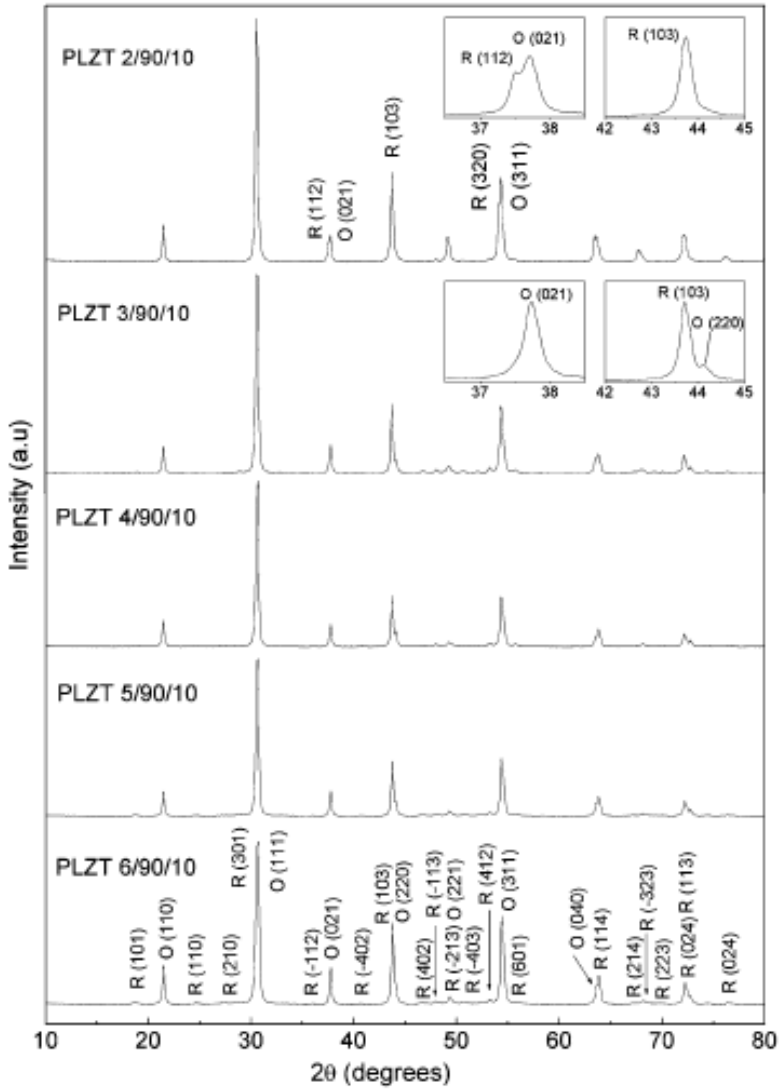

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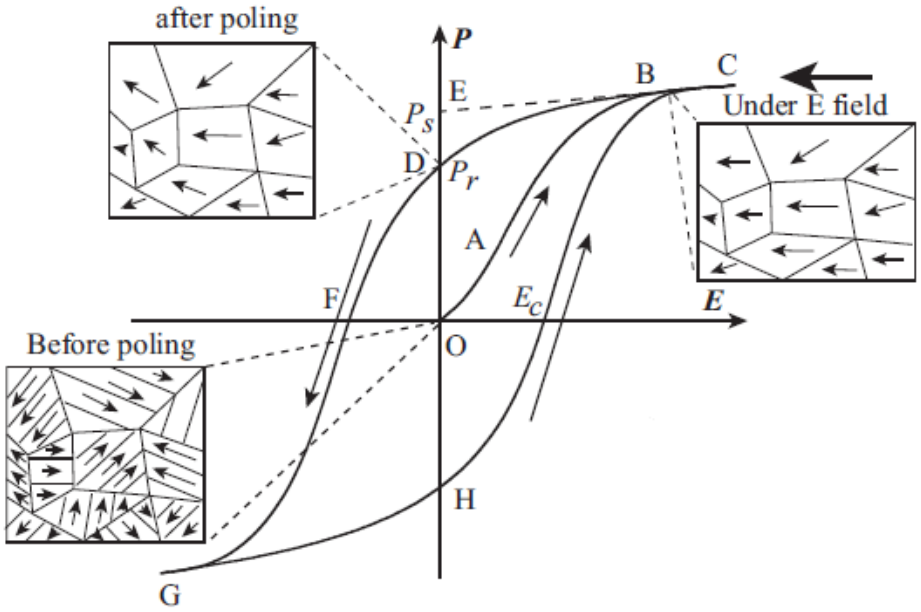
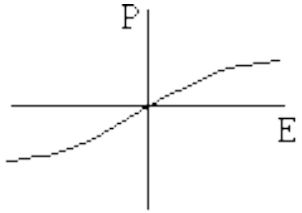
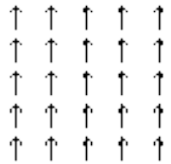


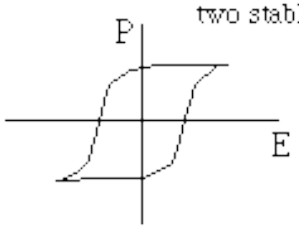
paraelectric



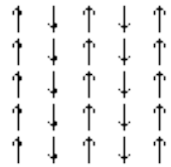
ferroelectric

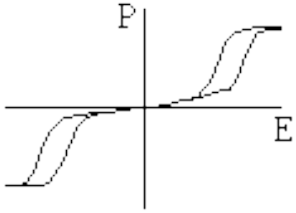


two stable states



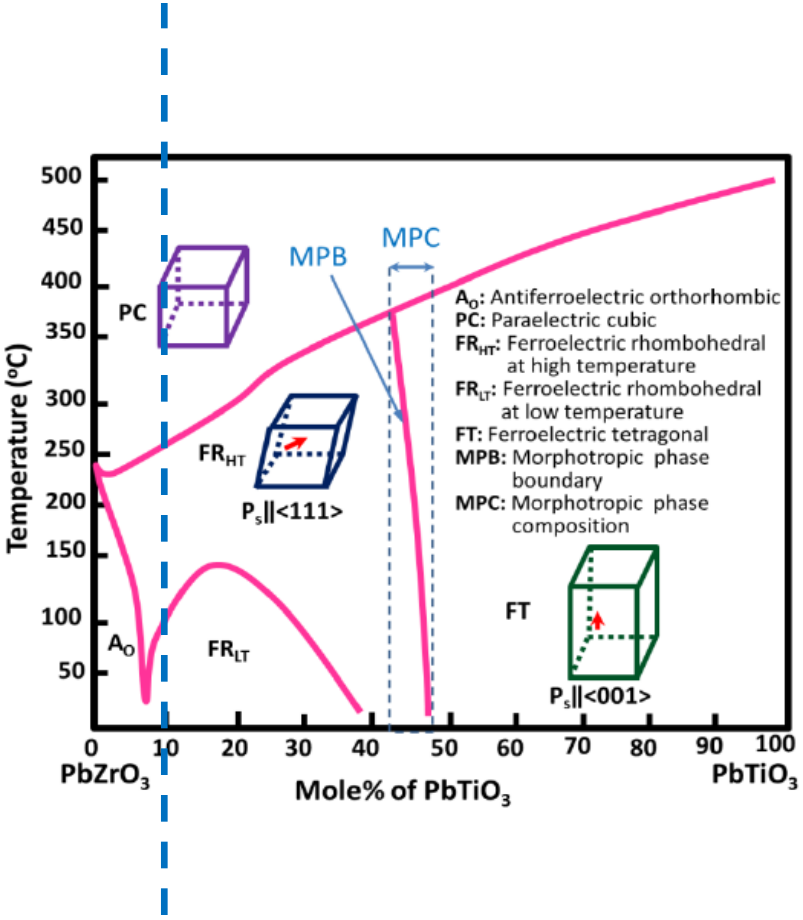
antiferroelectric





Compositional induced phase transition: Polarization- electric field hysteresis loop

Effects of lanthanum modification on dielectric properties of $Pb(Zr_{0.90},Ti_{0.10})O_3$ ceramics: enhanced antiferroelectric stability



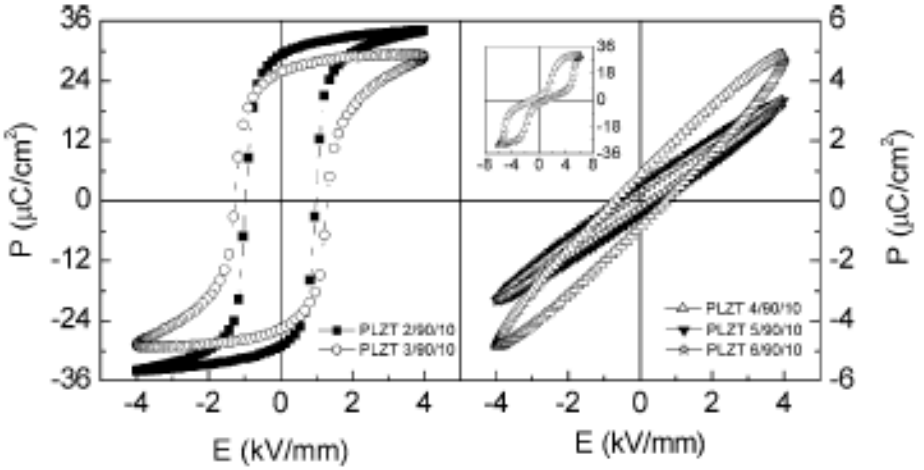
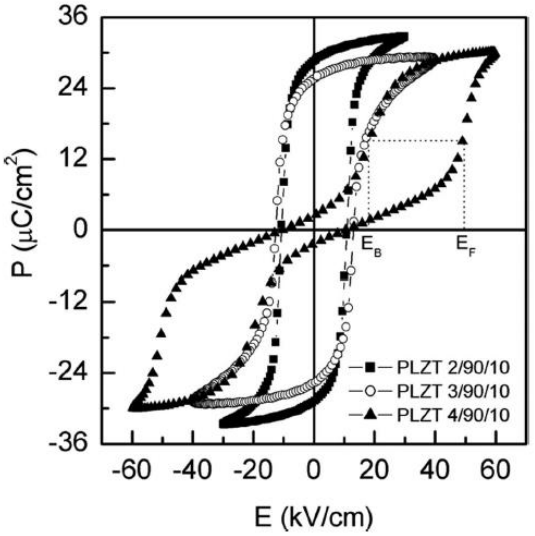


Fig. 5 Hysteresis loops obtained at room temperature for the PLZT *x*/90/10 studied compositions



3-Temperature induced phase transition

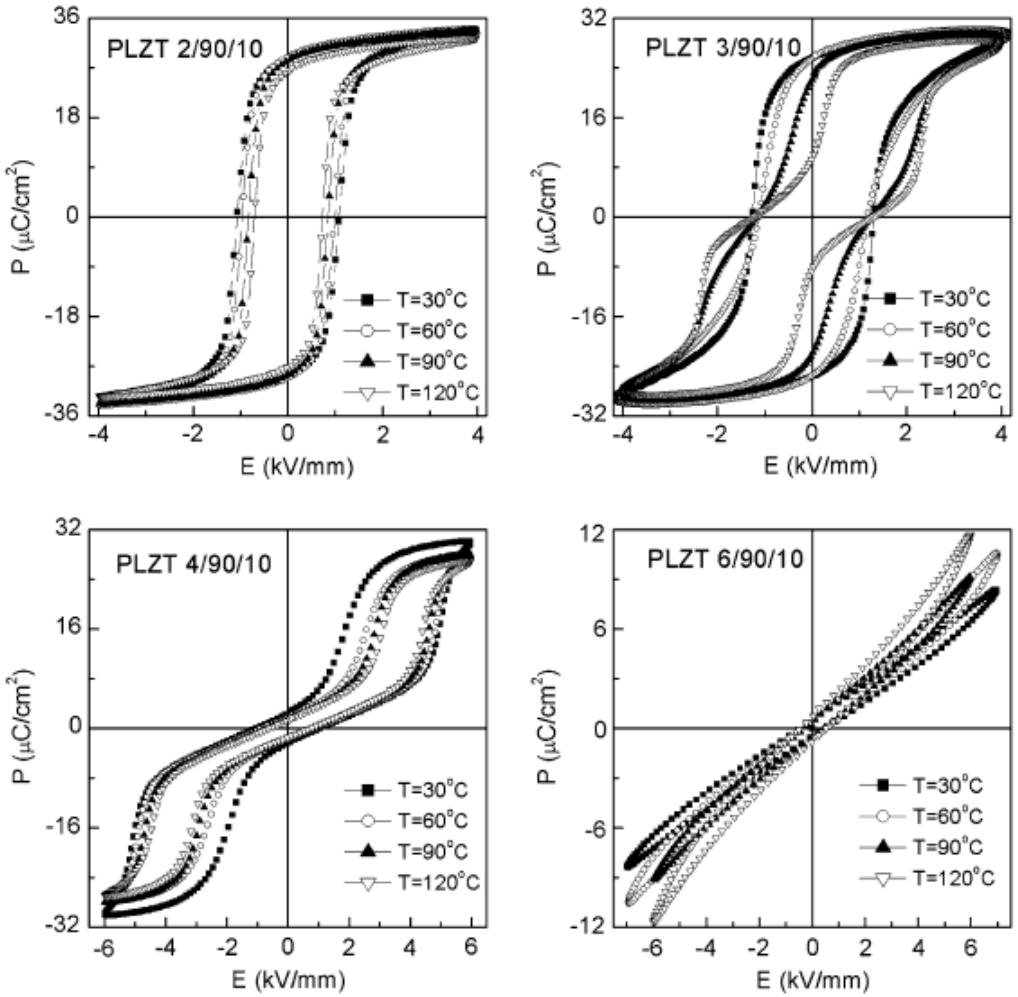
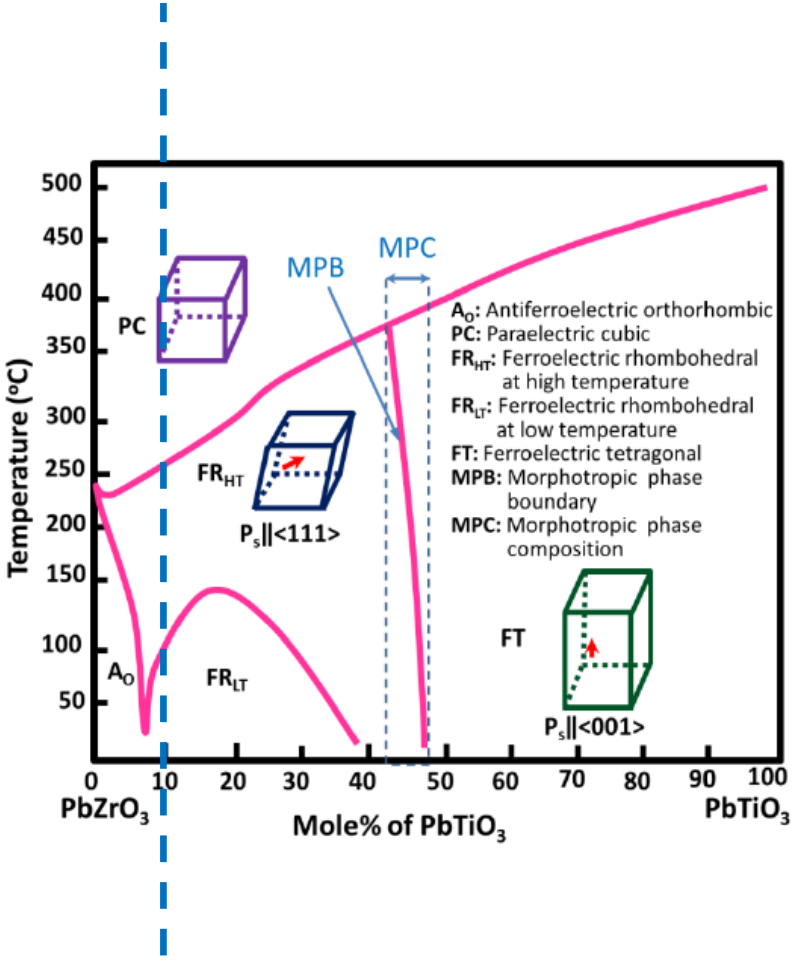


Fig. 6 Hysteresis loops for the PLZT *x*/90/10 ($x = 2, 3, 4, 6$ at% La), as a function of the temperature



4- Pressure induced phase transition

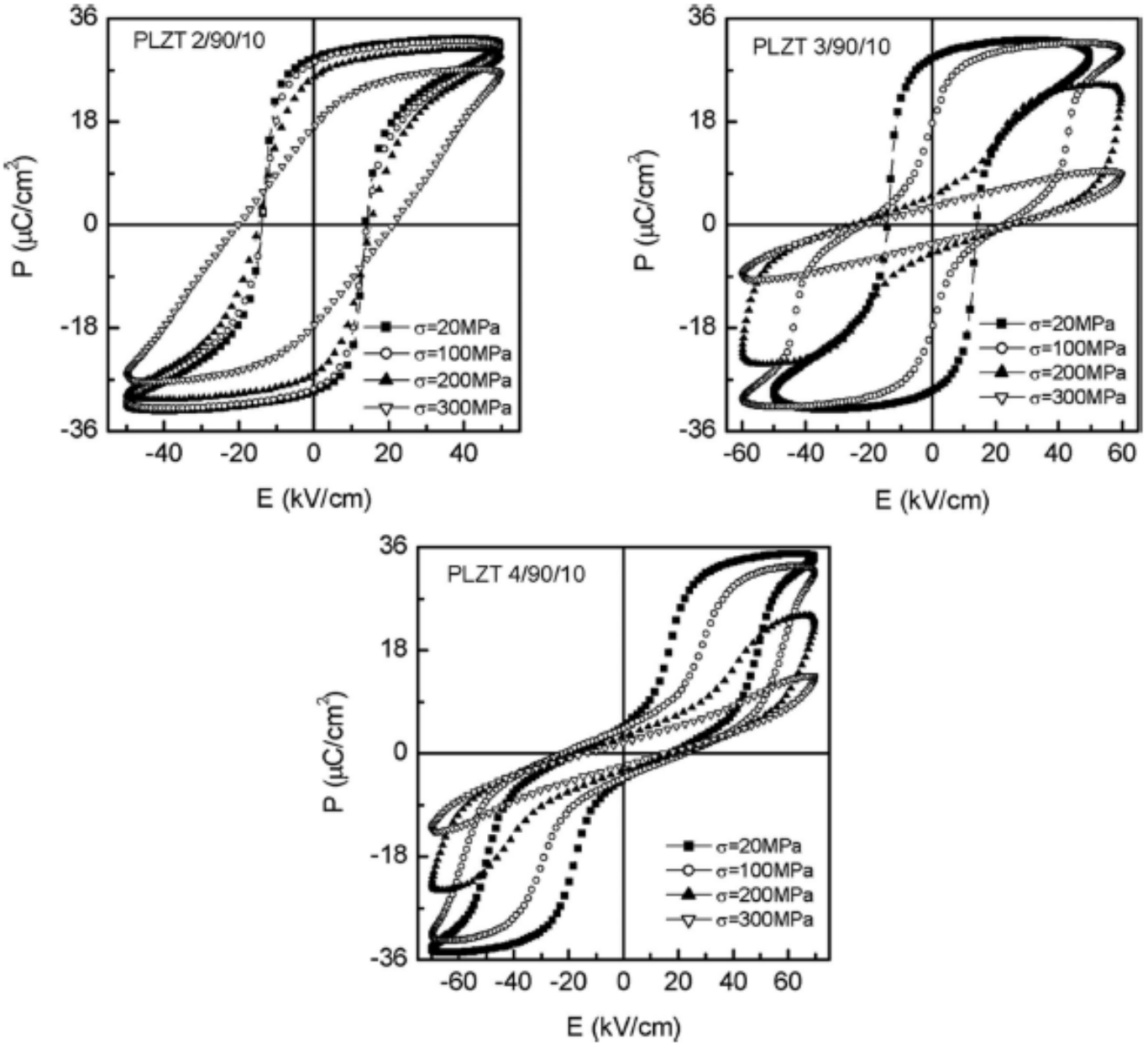


Fig. 3. Hydrostatic pressure dependence of the hysteresis loops for the studied compositions at room temperature.