fabrication of PZT film
measure of hysteresis loop

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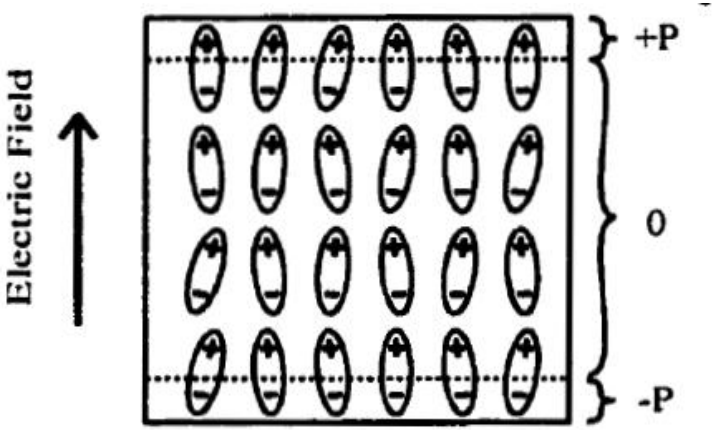
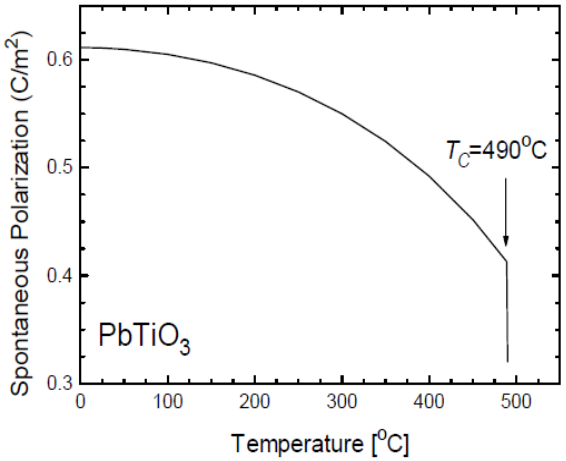
Ferroelectrics



Representation of the dipoles in a dielectric material placed in an electric field



In the presence of an external electric field, dielectric materials have the ability to form and align internal dipoles

at the edges the aligned dipoles effectively act as surface charges P
While most dielectrics will lose their polarization after the removal of the external field

some remain polarized. In an analogy to magnetism, the special subclass of dielectrics to which these materials belong is called ferroelectrics

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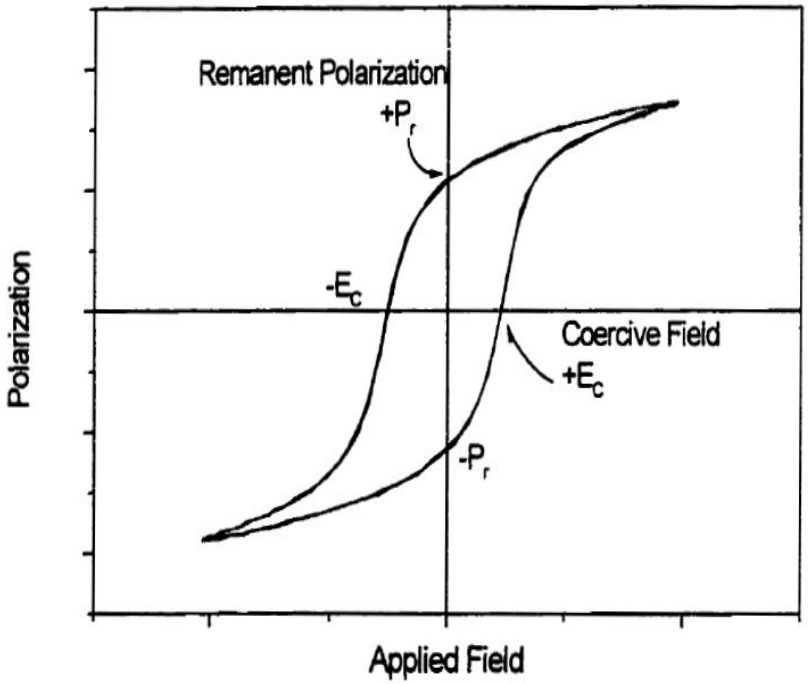
Curie temperature Tc
at which the remanent polarization disappears

Hysteresis loop



Remanent polarization(Pr) :

the surface charge that remains after the removal of the external field
(because spontaneous polarization)

Coercive Field(Ec) :

To change the direction of polarization of the size of the critical electric field

Internal area of the hysteresis curve :

electrical energy required for switching of the polarization

PZT(Pb(Zr, Ti)O3)

Characteristic

- Spontaneous polarization in the absence applied electrical field
- Extremely high dielectric constant (~500-15,000)
- Strong non-linear dielectric response to an applied electrical field
- High strain response to applied electrical field (piezoelectricity)
- Strong variation in polarization with temperature (piezoelectricity)

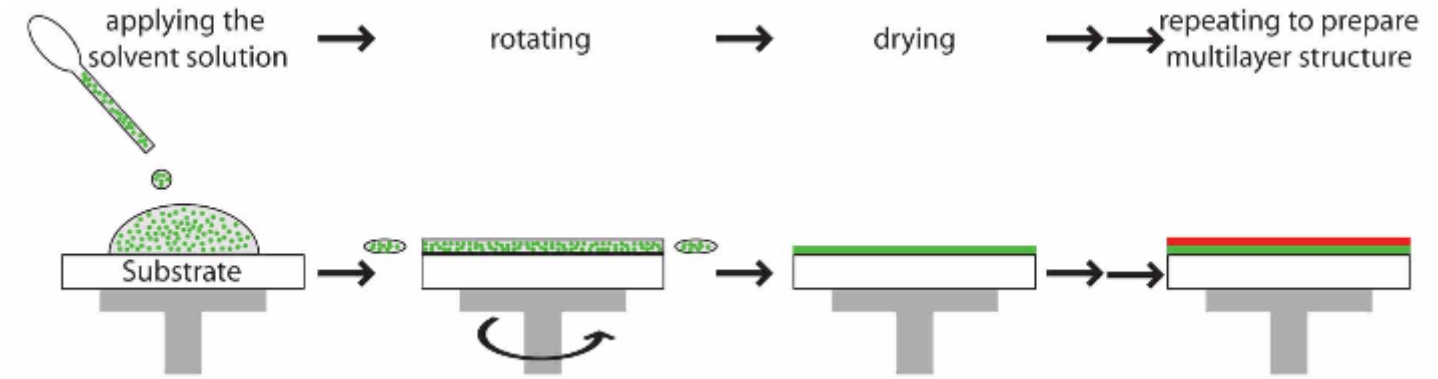
Pb(Zr, Ti)O3

- PbZrO3 + PbTiO3
- Zr : Ti (PbTiO3 is also increased with increasing permittivity)

Zr : Ti	20 : 80	30 : 70	40 : 60	52 : 48
permittivity	614	729	899	939

Fabrication of pzt film

Spin coating



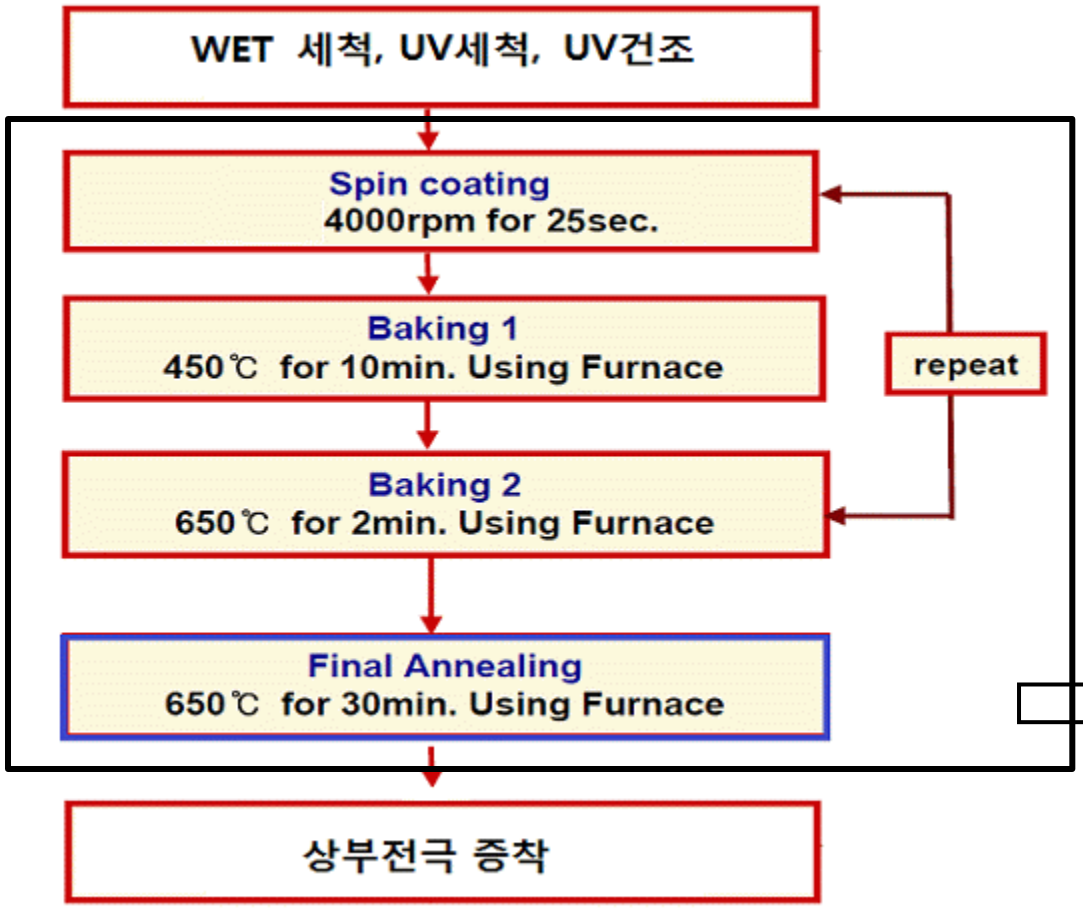
Spin coating is a cheap and fast method to produce homogeneous layers

The film thickness can be adjusted by varying the rotation speed, the rotation time and the concentration of the used solution.

The disadvantage of this method is that it is limited by the solvent and that no lateral resolution is possible.

Fabrication of pzt film

Spin coating

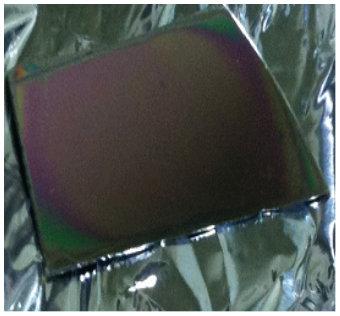


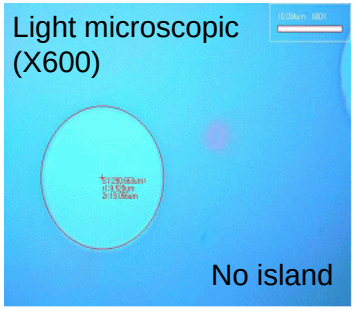
Annealing :

improves the crystallization and the electric properties of the film

Spin coater

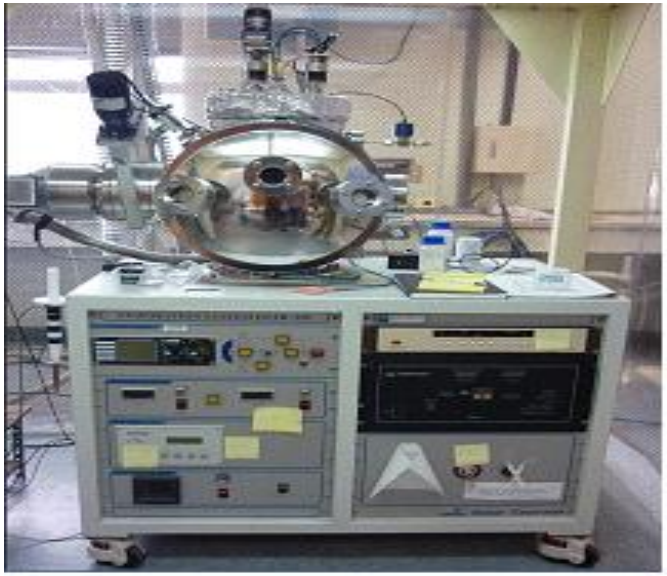
furnace

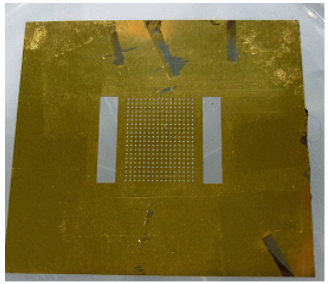




Fabrication of pzt film

Electron beam evaporation





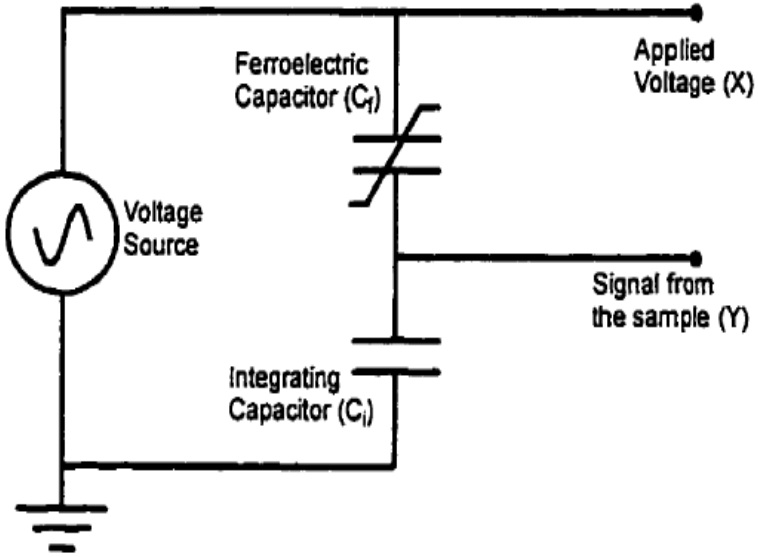
E-beam intensity : 89mA

Au evaporation : evaporation rate 0.5Å/s
thickness 500Å

Vacuum condition : 1.1×10^{-6} torr

Fabrication of pzt film

Sawyer-tower



In a circuit composed of two capacitors in series, the charges accumulating on each capacitor are equal. Realizing that the polarization P is given by

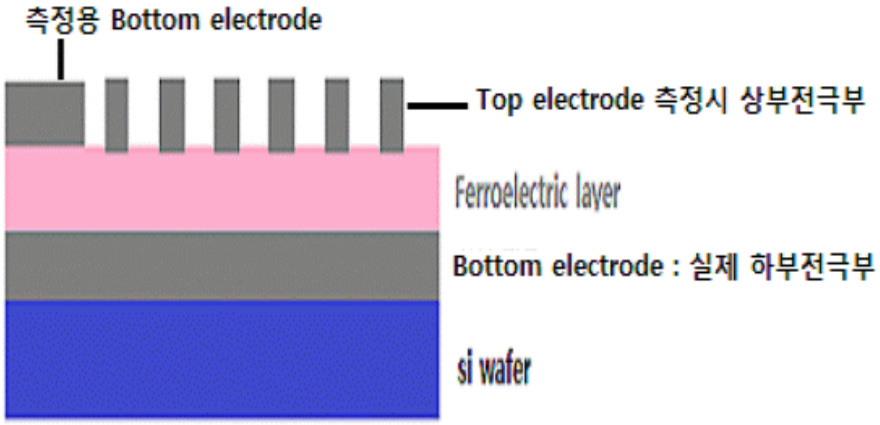
$$P = \frac{Q_f}{A_f}$$

where *Q,* is the charge on the ferroelectric capacitor and A, the area of the electrode and that the charge on both capacitors are equal, the polarization is then given by

$$P = \frac{Q_i}{A_f} = \frac{C_i \times V_i}{A_f}$$

Fabrication of pzt film

how can we measure polarization?



Resistance of ferroelectric layer

$$R = \frac{\rho \times t}{A}$$

R : resistance
A : area
ρ : resistivity
t : thickness

considering ferroelectric layer resistance
We think Series resistance circuit

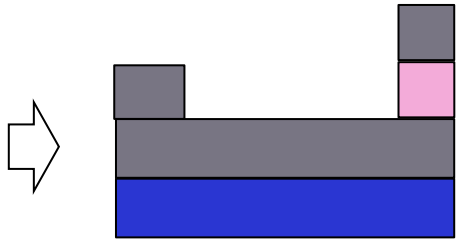
$$R = R_1 + R_2 = \frac{\rho \times t}{A_1} + \frac{\rho \times t}{A_2}$$

A_1 : top electrode

A_2 : bottom electrode

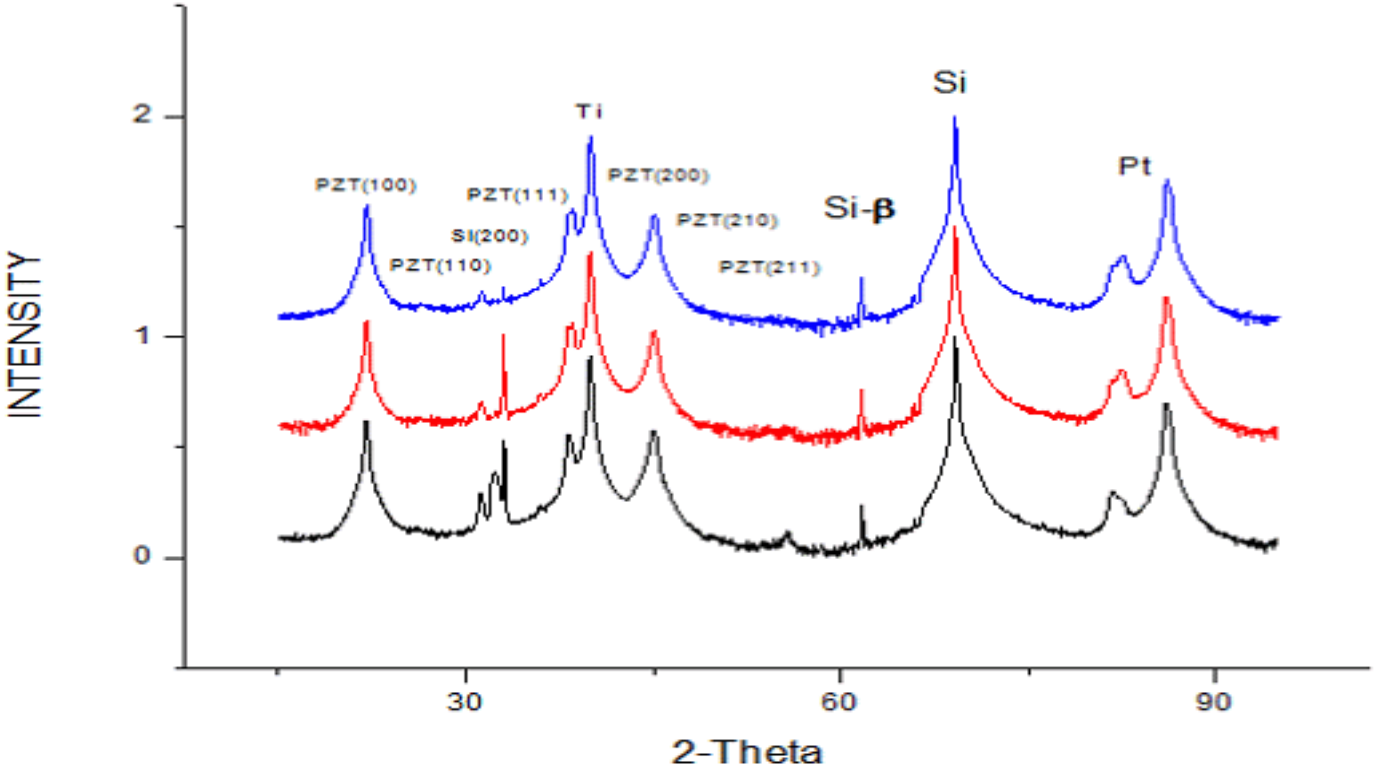
$$A_1 \gg A_2$$

$$R = R_1 + R_2 \approx \frac{\rho \times t}{A_2} = R_2$$



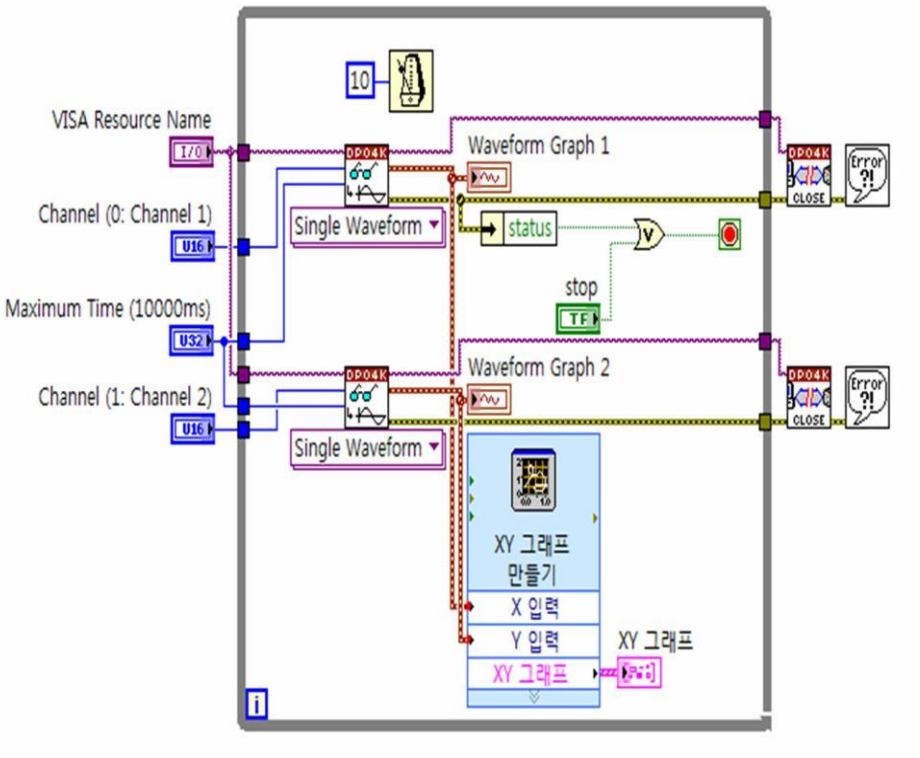
Result

XRD(X-ray Diffraction) graph

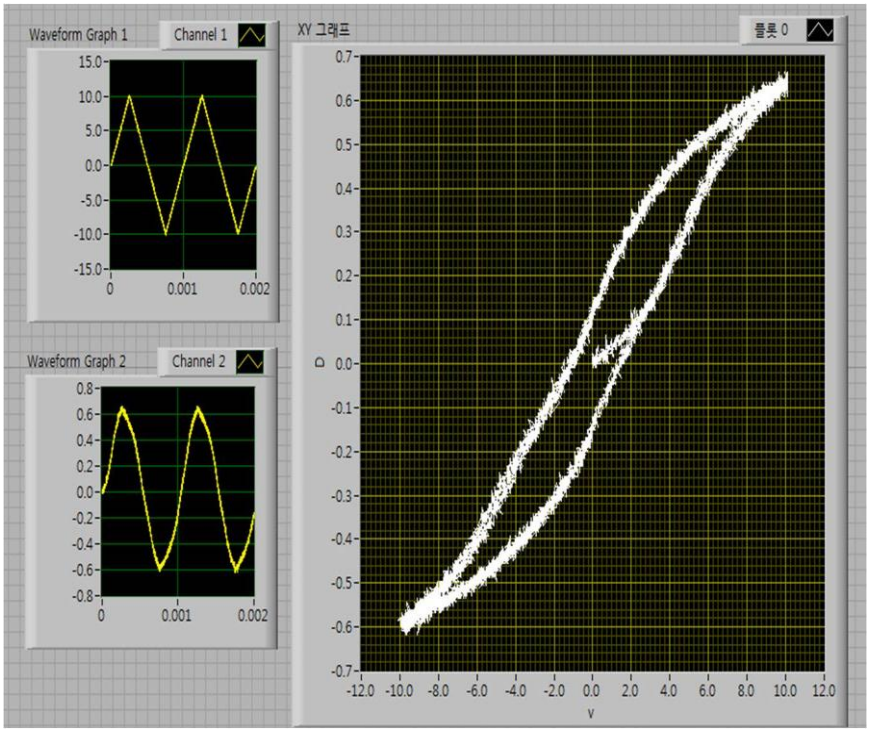


Result

measure of hysteresis loop by using LabVIEW



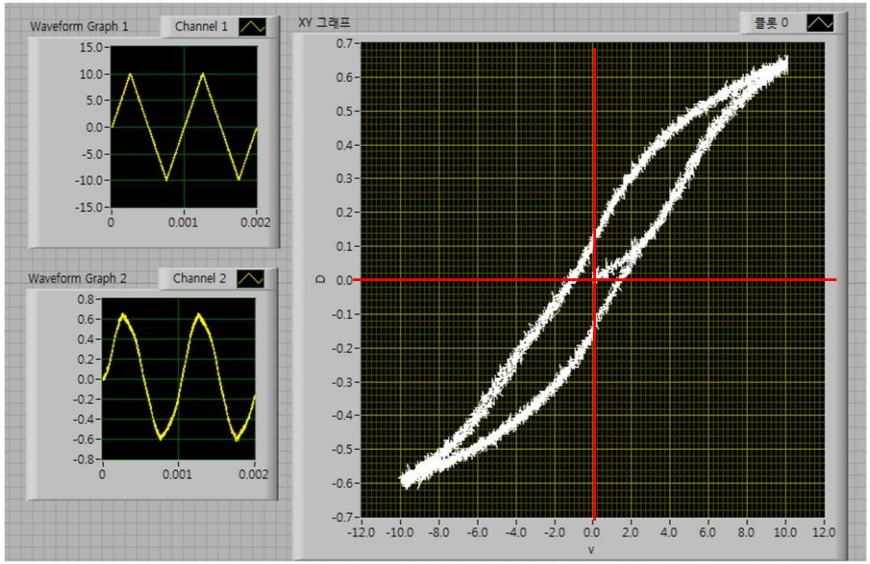
Block diagram

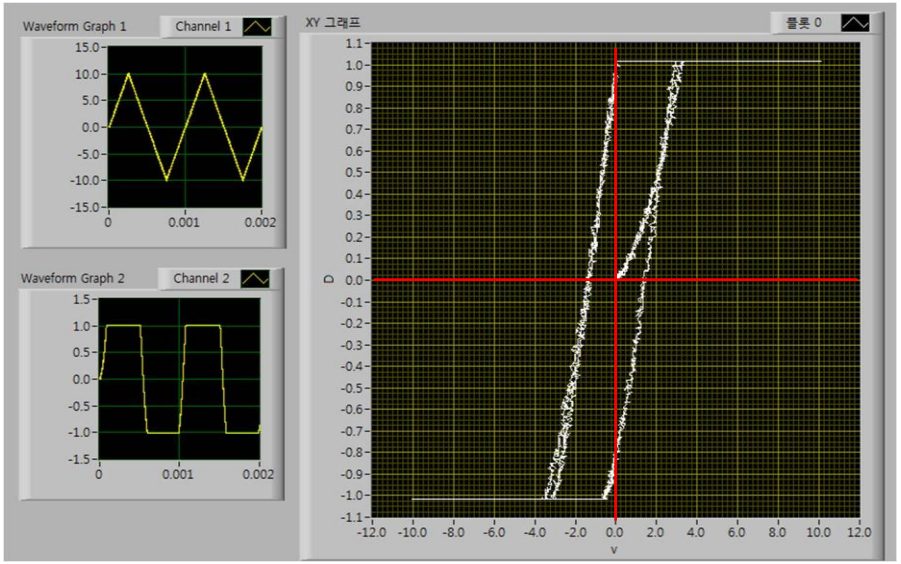


Front panel

Result

measure of hysteresis loop by using LabVIEW





	Ps(c/m^2)	Pr(c/m^2)	Ec (V)
Sample1	20.37	3.81	1.6
Sample2	16.98	14.15	1.2