



Polarization coupled response of ZnO-BaTiO₃: Determination of ZnO Spontaneous Polarization

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Polarization coupled interfaces



Is there a charge polarization exchange coupling in BTO/ZnO??
Can this be used to determine the amount of the spontaneous polarization in ZnO??

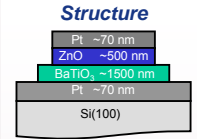
ZnO is a wurtzite structure typically n-type semiconductor with ionic interface charge (spontaneous polarization P_{sz}). This charge interacts with the switchable (ferroelectric) perovskite structure polarization P_s in BTO. This coupling influences the BTO index of refraction [1], the ferroelectric phase transition [2], and the rectifying electrical properties of ZnO/BTO heterostructures. We previously predicted that this coupling can be used to determine P_{sz} of ZnO. Here we report on electrical measurements of Pt/BTO/ZnO/Pt heterostructures, and our new model approach, in which we included the effect of a charge depletion layer in ZnO.

We obtain the first experimental value for the spontaneous polarization in ZnO:
 $P_{sz, ZnO} = -4 \mu\text{C}/\text{cm}^2$.

Previous theory calculation:
 $P_{sz, ZnO} = -5 \dots -5.7 \mu\text{C}/\text{cm}^2$ [4]

[1] Ann. Phys. 13, 61 (2004); [2] APL 86, 091904 (2005); [3] Thin Solid Films 486 (2005) 153; [4] PRB 56, R100024 (1997)

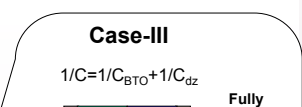
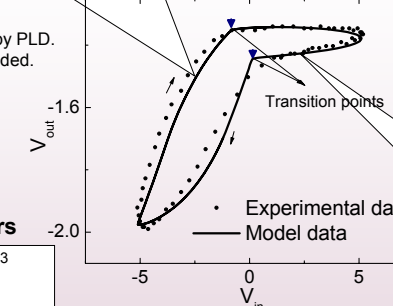
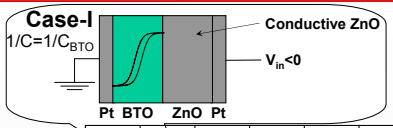
Sawyer-Tower circuit: Experiment and Model



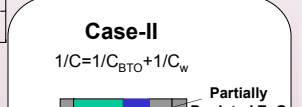
BTO and ZnO are grown by PLD. Bottom Metal (Pt) is grounded.

Best fit parameters

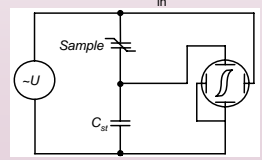
- $N_c = 5.5 \times 10^{22} / \text{m}^3$
- $\epsilon_{\text{BTO}} = 250$
- $\epsilon_{\text{ZnO}} = 8$
- $E_c = 1.2 \times 10^6 \text{ V/m}$
- $P_s = 14.1 \times 10^{-2} \text{ C/m}^2$
- $P_r = 6.35 \times 10^{-2} \text{ C/m}^2$
- $P_{sz} = -4.0 \times 10^{-2} \text{ C/m}^2$
- $R_s = 13 \text{ k}\Omega$



Case-III occurs at higher voltages



Case-II occurs at lower voltages



Sawyer-Tower circuit

Influence of model parameters on calculated Sawyer-Tower response

