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Self-Poling in Strained Asymmetric Superlattices[1]

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We have constructed strained dielectric superlattices consisting of three different perovskite titanate phases - $BaTiO_3$, $SrTiO_3$ and $CaTiO_3$ using ozone assisted atomic layer by layer molecular beam epitaxy, where the stacking architecture of the different phases controls the symmetry of the superlattice. To investigate the effect of structural symmetry (or the lack of symmetry) on the dielectric properties of such superlattices, avoiding effects due to asymmetric electrode interfaces, capacitor devices were constructed with symmetric, lattice-matched, conducting oxide electrodes. I will show that the stacking architecture modifies the dielectric and ferroelectric properties of the constituents leading to new electronic properties uncharacteristic of naturally occurring phases. Superlattices with broken inversion symmetry are self poled and generate a second order susceptibility, $\chi^{(2)}$, as a result of the built-in asymmetric strain fields. The resulting polarization direction and the sign of $\chi^{(2)}$ are fixed by the symmetry of the superlattice. Sensitive pyrocurrent measurements indicate an increasing polarization as the temperature is lowered while below a temperature, T_x, an onset of a hysteretic response is observed. I will discuss an unusual ferro-like phase with two unequal polarization states which emerges below T_x where the P-E loops are displaced not only along the E-field-axis by an effective polarizing field, but also along the P-axis by an offset polarization.

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