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Dielectric Superlattices with Broken Inversion Symmetry

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Dielectric phases with large electronic susceptibilities and high resistivity can be grown by ozone assisted atomic layer by layer molecular beam epitaxy. We have combined different perovskite titanate phases that have different unstrained lattice constants into fully strained superlattices in which inversion symmetry is broken. For example, a supercell consisting of one unit cell each of $CaTiO_3$, $SrTiO_3$ and $BaTiO_3$ is denoted 111+, while the opposite stacking ordering is called 111-. For testing, these superlattices are sandwiched between lattice matched conducting oxide electrodes and patterned into capacitor structures. In such superlattices, each layer is connected to two different phases. The TiO_3 octahedra in each layer asymmetrically distort because of the different strain each layer experiences. This results in a built-in polarization that persists at high temperatures in the paraelectric phases. The direction of the polarization is controlled by the molecular stacking architecture, "plus" or "minus." At low temperatures an unusual ferro-like phase develops with asymmetric polarization states. This work has been done in collaboration with Maitri Warusawithana, Hao Chen, Michael Weissman and Jian-Min Zuo and supported by the US Department of Energy