Artificially layered PbTiO$_3$/CaTiO$_3$ superlattices

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It has been shown that in artificially layered PbTiO$_3$/SrTiO$_3$ superlattices, a form of improper ferroelectricity occurs where the rotations of the oxygen octahedra at the interfaces couple with the polar mode and increase the ferroelectric polarization of the material when the layers are very thin. PbTiO$_3$/CaTiO$_3$ superlattices grown on SrTiO$_3$ substrates are also highly likely to display this kind of behavior, as the CaTiO$_3$ ground state is dominated by rotational distortions. This system should also play host to a competition between in-plane ferroelectricity (as CaTiO$_3$ is subjected to a large tensile strain when grown on SrTiO$_3$) and out-of-plane ferroelectricity (the usual result when in PbTiO$_3$ is grown on SrTiO$_3$). Using off-axis RF magnetron sputtering, we have produced high quality superlattices of PbTiO$_3$/CaTiO$_3$ with various layer thicknesses on SrTiO$_3$ substrates with SrRuO$_3$ bottom electrodes. The samples were analyzed using x-ray diffraction, electrical measurements, and atomic force microscopy. Our experimental results reveal a fascinating transition region at certain ratios of the relative layer thicknesses.

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Date submitted: 19 Nov 2010  
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