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Giant Enhancement of Ferroelectricity in Strained BaTiO3 Thin Films

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Epitaxial thin films often have quite different properties than bulk single crystals due to epitaxial and thermal strains arising from substrate constraints. This offers the opportunity to modify ferroelectric properties by heteroepitaxy and strain engineering. Biaxial compressive strain has been used to dramatically enhance the ferroelectric properties of $BaTiO_3$ thin films on (110) $GdScO_3$ and (110) $DyScO_3$ substrates [1]. This strain, imposed by commensurate epitaxy, can result in a ferroelectric transition temperature (T_c) nearly 500 $^\circ$C higher and a remanent polarization (P_r) at least 250% higher than bulk $BaTiO_3$ single crystals. This is the largest increase in T_c ever reported for a ferroelectric, and it is consistent with thermodynamic prediction. This work demonstrates a route to a lead-free ferroelectric for non-volatile memories and electro-optic devices, and is a general means for achieving extraordinary physical properties in thin films through strain engineering.
[1] K. J. Choi et al. *SCIENCE*, **306**, 1005 (2004). This work has been done in collaboration with K. J. Choi, M. Biegalski, Y. L. Li, A. Sharan, J. Schubert, R. Uecker, P. Reiche, Y. B. Chen, X. Q. Pan, V. Gopalan, L.-Q. Chen, D. G. Schlom.