SYSE 2: Strain engineering in ferroics and photonics

Time: Monday 16:15–18:00 Location: H1

Invited Talk SYSE 2.1 Mon 16:15 H1

Enhancing Ferroelectrics and Multiferroics using Strain — •D.G. Schlom[1], M.D. Biegalski[1], A. Soukiassian[1], J.H. Haeni[1], J.H. Lee[1], R.W. Ulbricht[1], C.M. Brooks[1], Y. Jia[1], V. Vaithyanathan[1], W. Tian[1], X. Ke[1], D.A. Tenne[1], A.V. Rao[1], A. Kumar[1], L. Tian[1], A. Sharan[1], S. Choudhury[1], Y.L. Li[1], P. Schiffer[1], S. Trolier-McKinstry[1], X.X. Xi[1], V. Gopalan[1], L.Q. Chen[1], K.J. Choi[2], D.M. Kim[2], C.B. Eom[2], Y.B. Chen[3], H.P. Sun[3], X.Q. Pan[3], D.D. Fong[4], M.A. Zurbuchen[4], J.A. Eastman[4], P.H. Fuoss[4], S.K. Streiffer[4], P. Irvin[5], J. Levy[5], W. Chang[6], S.W. Kirchoefer[6], T. Heeg[7], J. Schubert[7], A. Bruchhausen[8], N.D. Lanzillotti-Kimura[8], A. Fainstein[8], R.S. Katiyar[9], A. Cantarero[10], M.E. Hawley[11], Q.X. Jia[11], C.J. Fennie[12], S.M. Nakhmanson[12], K.M. Rabe[12], A.K. Tagantsev[13], B. Velickov[14], R. Uecker[14], and P. Reiche[14] — [1]Penn State U. — [2]U. Wisconsin-Madison — [3]U. Michigan — [4]Argonne — [5]U. Pittsburgh — [6]NRL — [7]FZ Jülich — [8]Centro Atómico Bariloche and Instituto Balseiro — [9]U. Puerto Rico — [10]U. Valencia — [11]Los Alamos — [12]Rutgers U. — [13]EPFL — [14]Institut für Kristallzüchtung

Aided by theoretical predictions, we have used epitaxy and the misfit strain imposed by an underlying substrate to enhance the ferroelectric properties of $SrTiO_3$, $BaTiO_3$, and $BaTiO_3/SrTiO_3$ superlattices. The enhancements include shifting the paraelectric-to-ferroelectric transition temperature by *hundreds* of degrees and maintaining ferroelectricity in $BaTiO_3$ layers as thin as one unit cell in $BaTiO_3/SrTiO_3$ superlattices. The effect of strain on $EuTiO_3$ will also be presented.

SYSE 2.2 Mon 16:45 H1

Piezoelectric strain control of thin film magnetism — •Kathrin Dörr and Christian Thiele — IFW Dresden, Postfach 270116, Dresden, Germany

Biaxial strain is a most crucial parameter influencing ferroic (ferroelectric, magnetic) properties of oxides. It is, on the other hand, not easily controlled independently of other parameters and in well-defined way. One approach for reversible biaxial strain variation in epitaxial films fitting to a pseudocubic lattice parameter of about 4.0 Angstrom is to utilize a 0.72PMN-0.28PT(001) substrate. The huge, homogeneous and nearly linear inverse piezoelectric strain of PMN-PT(001) allows one to biaxially compress as-grown films by applying electric voltage.

Ferromagnetic films of colossal magnetoresistive manganites $La_{1-x}A_xMnO_3$ (A = Sr; Ca) grown epitaxially on PMN-PT(001) have been subject to strain-dependent measurements of magnetization (M) and electrical resistance. For this family of materials, an extraordinary sensitivity towards external parameters (magnetic field, light, pressure) related to multiple phase neighbourhood is known. A pronounced shift of the Curie temperature with the strain is detected, naturally accompanied with strain dependence of M. The magnetoelectric coupling of the film-substrate system reaches a value of $\alpha = \mu_0$ dM/ dE = 6E-8 s/m (with substrate electric field E) at 300 K, revealing efficient strain-mediated coupling of the ferroic components. The observed resistive gauge factors of the films (400) further underline the strong impact of biaxial strain in manganites.

Invited Talk SYSE 2.3 Mon 17:00 H1

Patterning ferroelectric nanostructures by epitaxial strain — •Ho Nyung Lee and Matthew Chisholm — Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA

Strained, single-crystalline nanoferroelectrics were produced in a method that complements recent progress towards reducing the size of ferroelectric structures by e-beam direct writing, focused ion beam etching, and self-assembly. Processes such as FIB milling or reactive ion etching suffer from the disadvantage of chemical damage induced by the nature of the processes. Chemical solution derived nanoislands produced by self-assembly are sometimes problematic due to a lack of dimensional control and the presence of poly-crystalline phases and/or defects that cause severe degradation of physical properties. In this talk, we will present a novel method to produce strained single-crystalline nanoferroelectrics. Small feature sizes (< 40 nm) of $PbZr_{0.2}Ti_{0.8}O_3$ nanostructures can be readily produced, without employing any chemical etchants or mechanical patterning. In addition, a comparison of the properties of relaxed and strained films with both highly- and weakly-polar ferroelectrics will be presented, showing that the strong sensitivity of ferroelectric polarization to epitaxial strain varies considerably for different ferroelectric perovskites.

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Invited Talk SYSE 2.4 Mon 17:30 H1

Curl in Photonic Crystals Induced by Drying Stresses upon Sol-Gel Infiltration — •Vladimir Kitaev[1], Evangellos Vekris[2], and Geoffrey Ozin[2] — [1]Wilfrid Lauirer University, Waterloo, Ontario, Canada — [2]University of Toronto, Toronto, Ontario, Canada

Colloidal photonic crystals will be introduced starting with monodisperse colloids and their self-assembly to structural control of the confinement. Recent results on curl control in inverse opal structures achieved by fine-tuning of the sol-gel infiltration process will be discussed. The driving force of structural transformations is the gradient in contraction arising from the drying stress between the sol-gel infiltrated into the porous media of the colloidal crystals and its surface overlayer. The curvature of the resulting assemblies can be consequently adjusted through the control of the overlayer thickness during the infiltration. Structural continuity (absence of cracks) is successfully achieved by optimization of the drying conditions. Optical characterization of curled photonic crystals using UV-vis microspectroscopy confirmed high structural quality of the template preserved and demonstrated that the stopband reflection of the curled colloidal photonic crystals can be described by the Bragg's law.