Users of PARADIM Presenting at APS 2020

Monday, March 2, 2020

Time	Room	Presenter	Label	Updates
9:12 AM–9:24 AM	Mile High Ballroom 4E	Emily Lindgren	**A64.00005**	
9:36 AM–9:48 AM	707	Jinsong Xu	**A41.00009**	
12:51 PM–1:03 PM	Mile High Ballroom 4E	Grace Pan	**B64.00007**	
Poster 2:00 PM	Exhibit Hall C/D	Matthew J. Wahila	**C71.00104**	
4:06 PM–4:18 PM	709/711	Shiyu Fan	**D42.00006**	**New D42.5**
4:30 PM–4:42 PM	Mile High Ballroom 4E	Caitlin Kengle	**D64.00009**	
4:42 PM–4:54 PM	Mile High Ballroom 4E	Eli Gerber	**D64.00010**	

Tuesday, March 3, 2020

Time	Room	Presenter	Label	Updates
8:36 AM–8:48 AM	Mile High Ballroom 4B	Brendan Faeth	**F61.00002**	
9:00 AM–9:12 AM	Mile High Ballroom 4F	Mekhola Sinha	**F65.00006**	
10:48 AM–11:00 AM	707	Zhen Chen	**F41.00015**	
11:27 AM–12:03 PM	Mile High Ballroom 4E	Darrell Schlom	**G64.00002**	
12:15 PM–12:27 PM	Mile High Ballroom 4D	Jinwoo Hwang	**G63.00004**	
12:27 PM–12:39 PM	707	Isaiah Gray	**G41.00005**	
1:15 PM–1:27 PM	Mile High Ballroom 4D	Celesta Chang	**G63.00009**	
Poster 2.00 PM	Exhibit Hall C/D	Thomas Pekarek	**H71.00366**	**Now 71.365**
3:18 PM–3:30 PM	Mile High Ballroom 1A	Berit Hansen Goodge	**J48.00005**	
5:18 PM–5:30 PM	Mile High Ballroom 4F	Betul Pamuk	**J65.00013**	

Wednesday, March 4, 2020

Time	Room	Presenter	Label	Updates
9:24 AM–9:36 AM	Mile High Ballroom 1F	Ariana Ray	**L53.00004**	
1:15 PM–1:27 PM	Mile High Ballroom 4D	Sieun Chae	**M63.00009**	
1:39 PM–1:51 PM	Mile High Ballroom 1F	Elisabeth Bianco	**M53.00009**	

Thursday, March 5, 2020

Time	Room	Presenter	Label	Updates
8:24 AM–8:36 AM	708	Xiaojian Bai	**R46.00003**	
4:06 PM–4:18 PM	Mile High Ballroom 4B	Nathaniel Schreiber	**U61.00007**	
4:30 PM–4:42 PM	Mile High Ballroom 1F	Andrew Ye	**U53.00012**	**Now U53.11**

Friday, March 6, 2020

Time	Room	Presenter	Label	Updates
8:00 AM–8:36 AM	205	Derk Joester	**W18.00001**	
9:12 AM–9:24 AM	Mile High Ballroom 3B	Hari Nair	**W58.00007**	
9:48 AM–10:00 AM	703	Michael Matty	**W39.00009**	**New W39.8**
12:27 PM–12:39 PM	Mile High Ballroom 4C	Aaron Hui	**X62.00007**	

Monday, March 2, 2020

Time	Room	Presenter	Label	Updates
9:12 AM–9:24 AM	Mile High Ballroom 4E	Emily Lindgren	**A64.00005**	
9:36 AM–9:48 AM	707	Jinsong Xu	**A41.00009**	
12:51 PM–1:03 PM	Mile High Ballroom 4E	Grace Pan	**B64.00007**	
Poster 2:00 PM	Exhibit Hall C/D	Matthew J. Wahila	**C71.00104**	
4:06 PM–4:18 PM	709/711	Shiyu Fan	**D42.00006**	**New D42.5**
4:30 PM–4:42 PM	Mile High Ballroom 4E	Caitlin Kengle	**D64.00009**	
4:42 PM–4:54 PM	Mile High Ballroom 4E	Eli Gerber	**D64.00010**	

http://meetings.aps.org/Meeting/MAR20/Session/A64.5

Abstract: A64.00005 : Electronic and Magnetic Characterization of Doped Perovskite Stannate Epitaxial Thin Films*

9:12 AM–9:24 AM,
Room: Mile High Ballroom 4E

Authors:

Emily Lindgren
(Geballe Laboratory for Advanced Materials, Stanford University)

Hanjong Paik, Darrell Schlom
(Platform for the Accelerated Realization, Analysis, & Discovery of Interface Materials (PARADIM), Cornell University)

Carolina Adamo, Yuri Suzuki
(Geballe Laboratory for Advanced Materials, Stanford University)

Alpha T. N'Diaye
(Advanced Light Source, Lawrence Berkeley National Laboratory)

La-doped $BaSnO_3$ thin films have been identified as a promising high mobility semiconducting oxide, which could play an important role in the development of an all-oxide power electronics platform. In order to incorporate spin functionality into these materials, we explore magnetic doping of the conducting perovskite stannates. We have fabricated La and Ru doped $BaSnO_3$ and $SrSnO_3$ films on (001) $SrTiO_3$ substrates grown by molecular beam epitaxy (MBE) and pulsed laser deposition (PLD). X-ray diffraction (XRD) was used to verify epitaxial growth and confirm high crystalline quality, with typical omega rocking curve FWHM of 0.05^o deg. Films are optically transparent as verified by UV-vis spectrometry. They are also conductive, with room temperature mobilities up to 105 cm^2/Vs, and standard carrier electronconcentrations of 1-2x10^{20} $/cm^3$. Films show evidence of paramagnetism both in the field and temperature dependence of magnetization.

*We acknowledge support from the National Science Foundation (Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM)) under Cooperative Agreement No. DMR-1539918, as well as the National Science Foundation under grant #1762971.

Monday, March 2, 2020

http://meetings.aps.org/Meeting/MAR20/Session/A41.9

Abstract: A41.00009 : Large anomalous Nernst effect in a van der Waals ferromagnet Fe_3GeTe_2*

9:36 AM–9:48 AM,
Room: 707

Authors:

Jinsong Xu
(Johns Hopkins University)

William Adam Phelan, Chia-Ling Chien
(Johns Hopkins University)

Anomalous Nernst effect, a result of charge current driven by temperature gradient, provides a probe of the topological nature of materials due to its sensitivity to the Berry curvature near the Fermi level. Fe_3GeTe_2, one important member of the recently discovered two-dimensional van der Waals magnetic materials, offers a unique platform for anomalous Nernst effect because of its metallic and topological nature. Here, we report the observation of large anomalous Nernst effect in Fe_3GeTe_2. The anomalous Hall angle and anomalous Nernst angle are about 0.07 and 0.09 respectively, far larger than those in common ferromagnets. By utilizing the Mott relation, these large angles indicate a large Berry curvature near the Fermi level, consistent with the recent proposal for Fe_3GeTe_2 as a topological nodal line semimetal candidate. Our work provides evidence of Fe_3GeTe_2 as a topological ferromagnet, and demonstrates the feasibility of using two-dimensional magnetic materials and their band topology for spin caloritronics applications.

*This work was supported by the US Department of Energy, Basic Energy Science Aeard Grant No. DE-SC0009390. The bulk crystals growth was supported by the National Science Foundation under Cooperative Agreement No. DMR-1539918.

Monday, March 2, 2020

http://meetings.aps.org/Meeting/MAR20/Session/B64.7

Abstract: B64.00007 : Probing the electronic ground states of thin film Ruddlesden-Popper ($R_{n+1}Ni_nO_{3n+1}$) nickelates*

12:51 PM–1:03 PM
Room: Mile High Ballroom 4E

Authors:
Grace Pan
(Harvard University)

Qi Song, Charles Brooks, Spencer Doyle, James Ehrets, Dan Ferenc Segedin, Julia Mundy
(Harvard University)

Hanjong Paik
(PARADIM), Cornell University)

The recent discovery of superconductivity in a hole-doped infinite layer nickelate has spurred the reexamination of how nickelate physics may be amenable to stabilizing new superconducting phases [1]. The nickelate identified is isostructural to the superconducting cuprates and lies squarely in the superconducting regime of the simple phase diagram by Zhang [2] but disentangling the electronic from the structural contributions presents a key challenge. We have stabilized, for the first time, the Ruddlesden-Popper nickelates ($Nd_{n+1}Ni_nO_{3n+1}$) in thin film form up to n = 6. We will discuss how tuning of the Ruddlesden-Popper order alters the electronic ground states of the system including the nickel 3*d* occupancy and effects on the canonical metal-to-insulator transition.

[1] D. Li et al., *Nature* 572, 624-627 (2019).
[2] J. Zhang et al., *Nature Physics* 13, 964-869 (2017).

*This work is supported by the National Science Foundation (Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM)) under Cooperative Agreement No. DMR-1539918.

Monday, March 2, 2020

http://meetings.aps.org/Meeting/MAR20/Session/C71.104

Abstract: C71.00104 : Simultaneous Study of Structure and Correlation-Driven Transitions via X-ray Standing Waves*

2:00 PM, Monday, March 2, 2020
Room: Exhibit Hall C/D

Authors:

Matthew J. Wahila
(Physics, Applied Physics, and Astronomy, Binghamton University)

Galo J. Paez, Christopher Singh
(Physics, Applied Physics, and Astronomy, Binghamton University)

Nicholas F Quackenbush
(National Institute of Standards and Technology)

Hanjong Paik
(PARADIM, Cornell University)

Darrell Schlom
(Materials Science and Engineering, Cornell University)

Tien-Lin Lee
(Diamond Light Source)

Wei-Cheng Lee, Louis F. J. Piper
(Physics, Applied Physics, and Astronomy, Binghamton University)

The possibility of decoupling electronic phenomena from those of the lattice has been a hot topic when discussing correlated metal-insulator transition materials such as VO_2, NbO_2, or V_2O_3.[1] A mainly electronic transition could enable ultra-fast switching, thin film electronics, with little risk of the inevitable physical degradation associated with bulk structural transitions. However, the roles of structural (Peierls) and electron correlation (Mott) effects in driving these transitions continue to be debated in the literature.[2] Using x-ray standing waves (XSW) and high quality epitaxial thin films, we have now concurrently investigated both the structural and electronic transition within some of these correlated materials using a single technique, directly measuring their simultaneity or lack thereof for the first time. We discuss these results and their wider implications.

[1] Kalcheim, Y. et al. *Robust Coupling between Structural and Electronic Transitions in a Mott Material*. Phys. Rev. Lett. 122, 57601 (2019).
[2] Lee, W. C. et al. *Cooperative effects of strain and electron correlation in epitaxial VO_2 and NbO_2*. J. Appl. Phys. 125, 082539 (2019).

*This material is based upon work supported by the Air Force Office of Scientific Research under award number FA9550-18-1-0024.

Monday, March 2, 2020

NEW SLOT: http://meetings.aps.org/Meeting/MAR20/Session/D42.5

Abstract: D42.00005 : High temperature magnetism and charge ordering in multiferroic $(LuFeO_3)_m/(LuFe_2O_4)_1$ (m = 3, 7, 9)

4:06 PM–4:18 PM
Room: 709/711

Authors:

Shiyu Fan
(Physics and Astronomy, University of Tennessee, Knoxville)

Hena Das
(Laboratory for Materials and Structures, Tokyo Institute of Technology, Midori-ku, 4259 Nagatesuta, Yokohama, Kanagawa 226-8503, Japan)

Kevin Arthur Smith
(Chemistry, University of Tennessee, Knoxville, Tennessee, 37996, USA)

Alejandro R'ebola, Julia Mundy, David Anthony Muller, Megan Holtz, Craig J Fennie
(School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853, USA)

Ramamoorthy Ramesh
(Department of Materials Science and Engineering, University of California, Berkeley, California 94720, USA)

Charles Brooks, Darrell Schlom
(Kavli Institute at Cornell for Nanoscale Science, Ithaca, New York 14853, USA)

Stephen A McGill
(National High Magnetic Field Laboratory, Tallahassee, Florida 32310, USA)

We combined optical spectroscopy, magnetic circular dichroism, and first principles calculations to uncover the microscopic origin of the high temperature magnetism in multiferroic superlattices $(LuFeO_3)_m/(LuFe_2O_4)_1$, as well as the charge ordered state in the m = 3 case. Analysis of the dichroic spectra at characteristic energies reveals optical hysteresis loops of different Fe centers. Comparison between coercivity vs temperature curves indicates the bulk magnetization emanates mostly from the $LuFe_2O_4$ layer. Spectroscopic signature of the interface demonstrates that the larger Lu distortion only selectively increases the local magnetization of the Fe^{2+} and Fe^{3+} sites in the spin-up channel, which strengthens the exchange interaction, increases the total magnetization in the $LuFe_2O_4$ layer and enhances T_C. Comparison between the calculated and measured dichroic spectra affirms a non-polar charge ordered state in the (3, 1) case. These findings provide a site specific technique to analyze the complex interactions in the materials with multiple magnetic centers, and also broaden the possibilities in the hunt for novel multiferroics with high T_C and large magneto-electric coupling constant.

Monday, March 2, 2020

http://meetings.aps.org/Meeting/MAR20/Session/D64.9

Abstract: D64.00009 : Electronic and magnetic properties in three-component manganite films – the role of ordered interfaces and ionic size effects*

4:30 PM–4:42 PM
Room: Mile High Ballroom 4E

Authors:
Caitlin Kengle
(University of North Florida)

Maitri Warusawithana, Dakota Brown, James Payne, Thomas Pekarek
(University of North Florida)

The mixed-valent manganite, $La_{1-x}Sr_xMnO_3$, with x= 1/3 has been widely studied for its colossal magneto-resistive properties arising from the double exchange interaction. This material can be grown in thin-film form as a random alloy or an ordered superlattice. Here we grow films replacing 50% of the La with Y to make $La_{1/3}Y_{1/3}Sr_{1/3}MnO_3$ as both random alloys where La, Sr, and Y randomly occupy the A-site and ordered superlattices where the supercells comprise of single unit cells of $LaMnO_3$, $YMnO_3$, and $SrMnO_3$ stacked in sequence. While electronically La and Y are very similar, as both tend to be in a 3+ oxidation state in the crystal, we find contrastingly different electronic transport. The Y-substituted films exhibit a suppression of the metal-to-insulator transition compared to that of $La_{1/3}Sr_{2/3}MnO_3$. While the suppression is observed in both the ordered superlattice and the random alloy, we find it notably more amplified in the random alloy sample. We will discuss how ionic size effects and ordered interfaces affect the electronic and magnetic properties of these samples.

*This work was supported by NSF Grant No. DMR-16-26332. Select films were grown at Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM).

Monday, March 2, 2020

http://meetings.aps.org/Meeting/MAR20/Session/D64.10

Abstract: D64.00010 : Superconductivity in a Metal/Quantum Dimer Heterostructure*

4:42 PM–4:54 PM
Room: Mile High Ballroom 4E

Authors:

Eli Gerber
(Cornell University)

Jian-Huang She
(Cornell University)

Choong Hyun Kim
(Seoul National University)

Craig J Fennie
(Cornell University)

Michael J Lawler
(Cornell University)

Eun-Ah Kim
(Cornell University)

Recently we we proposed a new approach to engineering exotic superconductors based on a metal/quantum spin ice heterostructure. However, pyrochlore materials are difficult to grow and current models of their spin fluctuation spectra remain incomplete. In contrast, weakly-interacting spin dimer compounds such as Ba3Mn2O8 are experimentally tractable and their spin correlations can be calculated explicitly. In this work we focus on a new example of such a setup, the spin dimer compound Ba3Mn2O8 in heterostructure with electron-doped Ba3Sb2O8, and predict interfacial p+ip pairing at a few Kelvin. We also provide criteria for materializing the heterostructure using ab initio calculations. Hence we present a concrete proposal based on a controlled calculation predicting p+ip superconductivity in a metal/quantum dimer heterostructure.

*The authors acknowledge support through the NSF MRSEC program (DMR-1719875) and the Materials Innovation Platform grant DMR-1539918.

Tuesday, March 3, 2020

Time	Room	Presenter	Label	Updates
8:36 AM–8:48 AM	Mile High Ballroom 4B	Brendan Faeth	**F61.00002**	
9:00 AM–9:12 AM	Mile High Ballroom 4F	Mekhola Sinha	**F65.00006**	
10:48 AM–11:00 AM	707	Zhen Chen	**F41.00015**	
11:27 AM–12:03 PM	Mile High Ballroom 4E	Darrell Schlom	**G64.00002**	
12:15 PM–12:27 PM	Mile High Ballroom 4D	Jinwoo Hwang	**G63.00004**	
12:27 PM–12:39 PM	707	Isaiah Gray	**G41.00005**	
1:15 PM–1:27 PM	Mile High Ballroom 4D	Celesta Chang	**G63.00009**	
Poster 2.00 PM	Exhibit Hall C/D	Thomas Pekarek	**H71.00366**	**Now 71.365**
3:18 PM–3:30 PM	Mile High Ballroom 1A	Berit Hansen Goodge	**J48.00005**	
5:18 PM–5:30 PM	Mile High Ballroom 4F	Betul Pamuk	**J65.00013**	

http://meetings.aps.org/Meeting/MAR20/Session/F61.2

Abstract: F61.00002 : Superconducting Fluctuations and Pairing Enhancement in Ultra-Thin FeSe/SrTiO3

8:36 AM–8:48 AM
Room: Mile High Ballroom 4B

Authors:
Brendan Faeth
(Cornell University)

Shuolong Yang
(University of Chicago)

Jason Kawasaki
(Materials Science, University of Wisconsin-Madison)

Jocienne Nelson, Pramita Mishra, Darrell Schlom, Kyle M Shen
(Cornell University)

Chen Li
(Cal Tech)

A central challenge in understanding the Tc enhancement mechanism in FeSe/SrTiO3 monolayer films has been to decouple the myriad effects that the underlying substrate imposes on the superconductivity. Alkali surface-dosed multilayer films provide a natural comparison where the heavily electron-doped superconducting layer is constrained to the film-vacuum interface, analogous to the monolayer FeSe/STO interface but lacking any STO phonon contribution. To better understand the influence of the STO phonon contribution, we systematically explore the evolution of superconductivity as measured unambiguously by in situ electrical resistivity under varied conditions of film thickness, surface doping concentration, and substrate interface condition. In contrast to observations from spectroscopic probes which indicate a substantial enhancement in the pairing Tc, we observe only modest discrepancies in the zero-resistance temperature for surface doped layers in comparison to monolayer films. We demonstrate that this behavior is due to the shared influence of 2D fluctuation effects which act to suppress the resistive transition well below the cooper pair formation temperature, and discuss the implications of our results on the broader understanding of the FeSe/STO enhancement phenomenology.

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/F61.2

Abstract: F61.00002 : Superconducting Fluctuations and Pairing Enhancement in Ultra-Thin FeSe/SrTiO3

8:36 AM–8:48 AM
Room: Mile High Ballroom 4B

Authors:

Brendan Faeth
(Cornell University)

Shuolong Yang
(University of Chicago)

Jason Kawasaki
(Materials Science, University of Wisconsin-Madison)

Jocienne Nelson, Pramita Mishra, Darrell Schlom, Kyle M Shen
(Cornell University)

Chen Li
(Cal Tech)

A central challenge in understanding the Tc enhancement mechanism in FeSe/SrTiO3 monolayer films has been to decouple the myriad effects that the underlying substrate imposes on the superconductivity. Alkali surface-dosed multilayer films provide a natural comparison where the heavily electron-doped superconducting layer is constrained to the film-vacuum interface, analogous to the monolayer FeSe/STO interface but lacking any STO phonon contribution. To better understand the influence of the STO phonon contribution, we systematically explore the evolution of superconductivity as measured unambiguously by in situ electrical resistivity under varied conditions of film thickness, surface doping concentration, and substrate interface condition. In contrast to observations from spectroscopic probes which indicate a substantial enhancement in the pairing Tc, we observe only modest discrepancies in the zero-resistance temperature for surface doped layers in comparison to monolayer films. We demonstrate that this behavior is due to the shared influence of 2D fluctuation effects which act to suppress the resistive transition well below the cooper pair formation temperature, and discuss the implications of our results on the broader understanding of the FeSe/STO enhancement phenomenology.

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/F65.6

Abstract: F65.00006 : Introduction of spin centers in single crystals of $Ba_2CaWO_{6-\delta}$*

9:00 AM–9:12 AM
Room: Mile High Ballroom 4F

Authors:

Mekhola Sinha
(Johns Hopkins University)

Tyler J. Pearson, Danna Freedman
(Chemistry, Northwestern University)

Allen Scheie, Timothy Reeder, Hector K. Vivanco, William Adam Phelan, Tyrel McQueen
(Johns Hopkins University)

Electronic spins are ideal qubit candidates both for their modularity and their ease of manipulation with microwave radiation. While fundamentally, T_2, the spin-spin relaxation time, represents the functional operating time of a qubit, T_1, the spin-lattice relaxation time, is ultimately the most restrictive parameter, as T_1 represents the theoretical upper limit to T_2. Design approaches to maximize T_1 remain an open question. We report the coherence properties of W^{5+} spin centers in $Ba_2CaWO_{6-\delta}$ generated by oxygen vacancies. We characterized these defects by measuring the T_1 and T_2 times from T = 5 to 150 K. Correlation of the T_1 lifetimes obtained from pulse EPR with phonon modes obtained from the heat capacity data quantifies the contribution of respective phonon modes to the spin-phonon coupling in the system. These results demonstrate that systematic defect generation in double perovskite structures can generate viable paramagnetic point centers for quantum applications.

*This work was funded by PARADIM, a National Science Foundation Materials Innovation Platform (NSF DMR-1539918). TMM acknowledges the David and Lucile Packard Foundation. TJP acknowledges an NSF Graduate Research Fellowship (DGE-1324585). AS acknowledges the Gordon and Betty Moore foundation, EPIQS, GBMF4532.

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/F41.15

Abstract: F41.00015 : Imaging the internal spin structures of skyrmions by Lorentz scanning transmission electron microscopy*

10:48 AM–11:00 AM
Room: 707

Authors:
Zhen Chen
(Cornell University)

Teng Xu, Wanjun Jiang
(Department of Physics, Tsinghua University)

Gregory Fuchs, David Muller
(Cornell University)

Magnetic skyrmions are noncollinear spin textures that have been detected and studied using many different techniques. However, a detailed characterization of the internal spin structures of skyrmions, especially for skyrmions with diameters smaller than 100 nm, is experimentally challenging. These experiments are extremely important for defining the chirality and spin topology. Recent experiments show that Lorentz scanning transmission electron microscopy with a high-dynamic-range pixel array detector - Lorentz 4D-STEM, allows direct imaging of magnetic structures at a spatial resolution down to a few nanometers. Here we first show that Lorentz 4D-STEM technique combining with ptychography can be used to detect the detailed spin structures inside skyrmions and spin singularities in skyrmion lattices. We subsequently demonstrate the direct determination of the chirality of Néel-type skyrmions from the magnetic induction field distribution in an inclined sample setup. Using both fast, wide-field Lorentz TEM and quantitative, high-resolution Lorentz STEM, we are able to perform real-space imaging of magnetic spin textures at length scales that span microns down to a few nanometers.

*Supported by DARPA TEE program (D18AC00009).

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/G64.2

Abstract: G64.00002 : Breaking Symmetries to Create a Robust Room-Temperature Ferrimagnetic Ferroelectric in $LuFeO_3/CoFe_2O_4$ Superlattices

11:27 AM–12:03 PM
Room: Mile High Ballroom 4E

Author:
Darrell Schlom
(Materials Science and Engineering, Cornell University)

Materials that exhibit simultaneous order in their electric and magnetic ground states hold tremendous promise for use in next-generation, low-power memory and logic devices in which electric fields control magnetism. Such materials are, however, rare as a consequence of the competing requirements for ferroelectricity and magnetism, and until recently $BiFeO_3$ was the only material with this functionality at room temperature. Interface materials are a way to overcome these competing requirements, as was recently demonstrated for $(LuFeO_3)_m/(LuFe_2O_4)_1$ superlattices [J.A. Mundy et al. *Nature* **537** (2016) 523–527.]. The rumpling imposed by the geometric ferroelectric hexagonal $LuFeO_3$ imposes a local distortion on the neighboring $LuFe_2O_4$—a distortion that removes the mirror symmetry that the $LuFe_2O_4$ layers would otherwise have. This breaking of symmetry enables the $LuFe_2O_4$ to become simultaneously ferrimagnetic and ferroelectric. This rumpling is distinct from strain engineering because no macroscopic strain is involved. In this presentation we extend this atomically engineered design methodology to $LuFeO_3/CoFe_2O_4$ superlattices producing a robust ground state that is simultaneously ferroelectric and ferrimagnetic at temperatures well above room temperature.

* The work reported was performed in collaboration with the groups of Elke Arenholz (Advanced Light Source, LBNL), Julie A. Borchers (NIST), Craig J. Fennie (Cornell), Lena F. Kourkoutis (Cornell), Steven A. McGill (National High Magnetic Field Laboratory), David A. Muller (Cornell), Julia A. Mundy (Harvard), Janice L. Musfeldt (University of Tennessee), Ramamoorthy Ramesh (UC Berkeley), William D. Ratcliff (NIST), Peter Schiffer (Yale), and Andreas Scholl (Advanced Light Source, LBNL).

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/G63.4

Abstract: G63.00004 : Unusual Formation of Point Defects and Their Complexes in Ultra-wide Band Gap Beta-Ga2O3*

12:15 PM–12:27 PM
Room: Mile High Ballroom 4D

Authors:

Jared Johnson
(Ohio State Univ - Columbus)

Zhen Chen, David Muller
(Cornell University)

Joel Varley
(Lawrence Livermore National Laboratory)

Christine Jackson, Esmat Farzana, Aaron Arehart, Hsien-Lien Huang, Steven Ringel, Jinwoo Hwang
(Ohio State Univ - Columbus)

Chris Van de Walle
(University of California, Santa Barbara)

Beta-Ga2O3 has unique advantages including high breakdown voltage and availability as bulk substrates, which make it a viable candidate for next-generation power device applications. We present the first direct microscopic observation of the unusual formation of interstitial-divacancy complexes within beta-Ga2O3 lattice using atomic resolution scanning transmission electron microscopy. We observed that cation atoms are present in multiple interstitial sites, and each interstitial atom is paired with two adjacent vacancies. The observed structure is consistent with density functional theory calculation, which predicts them to be compensating acceptors. The number of the complexes increase as a function of Sn doping, which matches with the increase of the trap state at Ec - 2.1 eV measured using deep level optical spectroscopy, strongly suggesting that the defects correspond to that trap level. We also show that two neighboring complexes can further relax the structure in between, creating more cation vacancies. Our finding provides new crucial information on the exact structural origin of the properties of beta-Ga2O3 that has been unobtainable using other methods.

*We acknowledge support by the Department of Defense, Air Force Office of Scientific Research GAME MURI Program.

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/G41.5

Abstract: G41.00005 : "Magnetic Etch-a-Sketch" using the 1st-order phase transition in FeRh*

12:27 PM–12:39 PM
Room: 707

Authors:

Isaiah Gray
(School of Applied and Engineering Physics, Cornell University)

Antonio B Mei, Darrell Schlom
(Department of Materials Science and Engineering, Cornell University)

Yongjian Tang, Daniel Ralph
(Department of Physics, Cornell University)

Jürgen Schubert
(Peter Grünberg Institute (PGI-9)and Jara-Fundamentals of Future Information Technology, Forschungszentrum Jülich)

Don Werder
(Cornell Center for Materials Research, Cornell University)

Jason M Bartell
(Department of Materials Science and Engineering, Massachusetts Institute of Technology)

Gregory Fuchs
(School of Applied and Engineering Physics, Cornell University)

We demonstrate a novel approach for room-temperature rewritable magnetic patterning using the 1st-order phase transition from antiferromagnet (AF) to ferromagnet (FM) in FeRh. We employ epitaxial $Fe_{0.52}Rh_{0.48}$ films designed such that both phases are metastable at room temperature. Starting with the film in a uniform AF state, we write arbitrary patterns of FM phase using a focused pulsed laser with ~650 nm resolution. We image the FM patterns with anomalous Nernst microscopy and show that they are stable under magnetic field – at least up to 3 kOe – as well as elevated temperature up to ~315 K. The FM patterns can be written using a single picosecond laser pulse per pixel and can be fully erased by cooling the film below room temperature.

Ref: A. B. Mei et al, *arXiv:1906.07239 (2019)*

*This work was supported in part by the Cornell Center for Materials Research with funding from the National Science Foundation MRSEC program (DMR-1719875). This work made use of the Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM), supported by the NSF (No. DMR-1539918), and the Cornell Nanoscale Facility, a member of the National Nanotechnology Coordinated Infrastructure (NNCI) supported by the NSF (Grant No. ECCS-1542081).

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/G63.9

Abstract: G63.00009 : Direct Imaging on Strain Relaxation of MBE-grown Single Phase alpha-$(Al,Ga)_2O_3$ on m-sapphire Substrate in Atomic Resolution Using Scanning Transmission Electron Microscopy*

1:15 PM–1:27 PM
Room: Mile High Ballroom 4D

Authors:

Celesta Chang
(Department of Physics, Cornell University)

Riena Jinno
(Electrical and Computer Engineering, Cornell University)

Debdeep Jena, Huili Grace Xing
(Electrical and Computer Engineering, Cornell University)

David Anthony Muller
(Applied and Engineering Physics, Cornell University)

MBE-grown corundum structured alpha-Ga_2O_3 on c-plane sapphire substrates often contains considerable amount of beta-Ga_2O_3 due to c-plane facets. Recently, a successful MBE-growth of pure alpha-$(Al, Ga)_2O_3$ on m-plane sapphire was reported. Here, we show the relaxation mechanism of such films by performing strain analysis with scanning transmission electron microscopy (STEM). The films are partially relaxed through dislocation cores at the interface, some of which tend to climb up into the film. High angle annular dark field (HAADF)-STEM images in plan-view shows the formation of very thin gamma-Ga_2O_3 at the interface occupying less than 1% area density. Owing to its defect spinel-type structure that requires two cation vacancies, gamma-Ga_2O_3 is believed to form naturally at the interface to accommodate the strain arising from lattice mismatch.

*This material is based on the work supported by the Cornell Center for Materials Research (CCMR) Shared Facilities, which are supported through the NSF MRSEC program (No.DMR-1719875). This work is supported by the Cornell/AFOSR ACCESS center of excellence (No. FA9550-18-1-0529).

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/H71.365

Abstract: H71.00365 : Magnetic Properties of MBE Grown $La_{1/3}Y_{1/3}Sr_{1/3}MnO_3$ thin films and Superlattices*

2:00 PM, Tuesday, March 3, 2020
Room: Exhibit Hall C/D

Authors:
Thomas Pekarek
(Univ of North Florida)

Caitlin Kengle, James Payne, Dakota Brown, Maitri Warusawithana
(Univ of North Florida)

We have investigated the magnetic properties of thin films related to the standard CMR system $La_{2/3}Sr_{1/3}MnO_3$ where Y substituted for 50% of the La atoms. These $La_{1/3}Y_{1/3}Sr_{1/3}MnO_3$ films were grown as a random alloy where La, Y, and Sr atoms randomly occupied the A-site or as a superlattice where each unit-cell-thick layer stacked along the crystallographic (001) direction contained only one of the atoms La, Y, and Sr occupying the A-site. One key magnetic feature of $La_{2/3}Sr_{1/3}Mn0_3$ is a prominent ferromagnetic transition near 350 K. We find the substitution of La with Y suppresses this ferromagnetic transition in both the random alloy and the superlattice samples. In the superlattice sample we find a magnetic transition that is coincident with a metal-to-insulator transition observed in electronic transport. In the random alloy sample, we see a similar magnetic transition but at lower temperatures, where we find the sample is too insulating to measure electronic transport. We will compare our measurements on these $La_{1/3}Y_{1/3}Sr_{1/3}MnO_3$ samples with CMR thin films of $La_{2/3}Sr_{1/3}MnO_3$.

*T.M.P. acknowledges support from the UNF Terry Presidential Professorship and the National Science Foundation Grant DMR-1626332. Some of the samples studied were grown at NSF funded PARADIM (DMR-1539918).

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/J48.5

Abstract: J48.00005 : Atomic Lattice and Electronic Structure of Superconducting Nickelate Thin Films*

3:18 PM–3:30 PM
Room: Mile High Ballroom 1A

Authors:

Berit Goodge
(Cornell University)

Danfeng Li, Kyuho Lee, Motoki Osada, Bai Yang Wang, Harold Hwang
(Stanford University)

Lena Fitting Kourkoutis
(Cornell University)

The recent discovery of superconductivity in Sr-doped $NdNiO_2$ is an important development for condensed matter physics [1]. Nominally similar in structure to the infinite-layer cuprate superconductors, the nickelates present a complementary platform for investigating the underlying physical mechanisms driving superconductivity in these systems. The stabilization of superconducting samples is, however, as yet limited to thin film geometries, raising the importance of spatially localized characterization techniques capable of probing only the regions of interest without contributions from the substrate. Here, we harness the high spatial and energy resolution achieved with scanning transmission electron microscopy (STEM) and electron energy loss spectroscopy (EELS) to explore both the lattice and electronic structure of these superconducting thin films. Structurally, the effects of different growth parameters are explored across several films within the nickelate series. Electronically, we investigate possible similarities to the cuprate superconductors.

[1] Li, et al. *Nature* **572**, 624 (2019).

*This work is supported by DOD AFOSR (FA 9550-16-1-0305), DOE BES MSD (DE-AC02-76SF00515), and the Moore Foundation (GBMF4415).

Tuesday, March 3, 2020

http://meetings.aps.org/Meeting/MAR20/Session/J65.13

Abstract: J65.00013 : Electron-phonon coupling in nitride superconductors from first principles: The effect of epitaxial strain and nitrogen concentration on superconducting properties*

5:18 PM–5:30 PM
Room: Mile High Ballroom 4F

Authors:
Betul Pamuk
(Cornell University)

Guru Khalsa
(Cornell University)

The recent all-epitaxial integration of NbN superconductors with the III-Nitride family of semiconductors by molecular beam epitaxy has created an opportunity for scalable, integrated semiconductor/superconductor devices with access to industrial fabrication processes [Nature 555, 183–189 (2018)]. NbN has a large superconducting critical temperature (T_c) that makes it a useful superconducting component at liquid helium temperature, but its structural, metallic, and superconducting properties are extremely sensitive to growth conditions and nitrogen concentration. Group IV-B Nitrides (Ti, Zr, Hf) are chemically more stable than NbN, but their T_c's are markedly smaller. Can the recent demonstration of epitaxial integration of transition metal nitrides with III-Nitrides be used as a strategy for tailoring their superconducting properties?

Using first-principles approaches we explore the effect of epitaxial strain and nitrogen concentration on Group IV-B Nitride superconducting properties. We find that both epitaxial strain and nitrogen concentration can drastically alter the electron-phonon coupling and potentially increase T_c to temperature ranges sensible for superconducting devices.

*NSF PARADIM: DMR-1539918
ONR (monitored by Dr. Paul Maki)

Wednesday, March 4, 2020

Time	Room	Presenter	Label	Updates
9:24 AM–9:36 AM	Mile High Ballroom 1F	Ariana Ray	**L53.00004**	
1:15 PM–1:27 PM	Mile High Ballroom 4D	Sieun Chae	**M63.00009**	
1:39 PM–1:51 PM	Mile High Ballroom 1F	Elisabeth Bianco	**M53.00009**	

http://meetings.aps.org/Meeting/MAR20/Session/L53.4

Abstract: L53.00004 : Imaging domains and defects in the stacking of few-layer and twisted CrI_3*

9:24 AM–9:36 AM
Room: Mile High Ballroom 1F

Authors:

Ariana Ray
(Physics, Cornell University)

Jie Shan
(Physics, Cornell University)

Yu-Tsun Shao, Yang Xu, Nikhil Sivadas, Tingxin Li, Zefang Wang, Kin Fai Mak, David Anthony Muller (Applied and Engineering Physics, Cornell University)

Different lateral shifts of the stacked monolayers in CrI3 lead to different magnetic ground states, with a rhombohedral-symmetry stacking resulting in ferromagnetic layer ordering, and a monoclinic-symmetry stacking leading to antiferromagnetic layer ordering. Here we explore the structural arrangements found as the CrI3 thickness is systematically reduced to the monolayer limit using 4D-STEM electron diffraction and atomic resolution imaging. We find that CrI3 flakes from bilayer to 50 nanometer thickness remain in a monoclinic stacking when cooled to 95 K. However, the monoclinic group allows for multiple variants -- arising from 120 degree stacking rotations both in-layer and between neighboring CrI3 layers -- and we observe a rich assortment of stacking orders and domains, as well as moirés. We show that these stacking rotations can change as a function of temperature. The observed vertical superposition of monoclinic variants in few-layer to bulk CrI3 flakes may present as an overall three-fold symmetry to macroscopic-averaged measurement, but can be recognized by atomic resolution imaging.

*Research supported by PARADIM DMR-1539918, AFOSR MURI FA9550-18-1-0480, CCMR DMR-1719875

Wednesday, March 4, 2020

http://meetings.aps.org/Meeting/MAR20/Session/M63.9

Abstract: M63.00009 : Rutile GeO_2: an ultra-wide-band-gap semiconductor with ambipolar doping

1:15 PM–1:27 PM
Room: Mile High Ballroom 4D

Authors:

Sieun Chae
(Univ of Michigan - Ann Arbor)

Kelsey A. Mengle
(Univ of Michigan - Ann Arbor)

Hanjong Paik
(Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM), Cornell University)

Jihang Lee, John Heron, Emmanouil Kioupakis
(Univ of Michigan - Ann Arbor)

Ultra-wide-band-gap (UWBG) semiconductors have tremendous potential to advance electronic devices as device performance improves superlinearly with increasing gap. Ambipolar doping, however, has been a major challenge for UWBG materials as dopant ionization energy and charge compensation generally increase with increasing band gap. Using hybrid density functional theory, we demonstrate rutile germanium oxide (r-GeO_2) to be an alternative UWBG (4.68 eV) material that can be ambipolarly doped. We identify Sb_{Ge}, As_{Ge}, and F_O as possible donors with low ionization energies and propose growth conditions to avoid charge compensation by native acceptor-type defects. Acceptors such as Al_{Ge} have relatively large ionization energies (0.45 eV) due to the formation of localized hole polarons. Yet, we find that the co-incorporation of Al_{Ge} with H_i can increase the solubility limit of Al and enable hole conduction in the impurity band. We also calculate electron (153.6 $cm^2V^{-1}s^{-1}$) and hole mobilities (4.7 $cm^2V^{-1}s^{-1}$) of r-GeO_2 at 300 K, suggesting r-GeO_2 has outstanding electronic properties that can compete with the state-of-the-art UWBG semiconductors such as β-Ga_2O_3. We will also discuss on our recent experimental progress on thin-film growth and electrical characterization of r-GeO_2.

Wednesday, March 4, 2020

http://meetings.aps.org/Meeting/MAR20/Session/M53.9

Abstract: M53.00009 : Unraveling the Relationship Between Layer Stacking and Magnetic Order in Nb_3X_8 Systems*

1:39 PM–1:51 PM
Room: Mile High Ballroom 1F

Authors:
Elisabeth Bianco
(Cornell University)

Ismail El Baggari, Berit Goodge, Lena Kourkoutis
(Cornell University)

Christopher Pasco, Tyrel McQueen
(Johns Hopkins University)

Niobium halides of form Nb_3X_8 (X=Cl or Br) are cluster-based, 2D materials that exhibit an antiferromagnetic to non-magnetic transition. In Nb_3Cl_8, the loss of magnetic order occurs below 90 K and has been coupled to a layer re-stacking from a 2-layer (α-phase) to 6-layer (β-phase) unit cell. The transition temperature, however, depends strongly on composition with Nb_3Br_8 transitioning at 293 K. While tuning magnetic ordering temperature through composition is appealing, the layer re-stacking mechanism is not understood. Here, we used controlled-temperature cryogenic scanning transmission electron microscopy (cryo-STEM) to study the re-stacking in Nb_3Br_8 with atomic-resolution. Our results reveal a reversible transformation from the α-phase to β-phase at ~250 K upon cooling and the reverse at ~425 K upon heating through a series of intermediate phases. Tracking the emergence of intermediates with electron diffraction and Multislice image simulations provides a clearer picture of favorable stacking configurations for van der Waals Nb_3X_8. Understanding these stacking changes and their effect on magnetic ordering will afford handles for materials with tailored transition temperatures.

*This work is supported by PARADIM, an NSF-MIP (DMR-1539918), and NSF DMR-1429155 & DMR-1719875

Thursday, March 5, 2020

Time	Room	Presenter	Label	Updates
8:24 AM–8:36 AM	708	Xiaojian Bai	**R46.00003**	
4:06 PM–4:18 PM	Mile High Ballroom 4B	Nathaniel Schreiber	**U61.00007**	
4:30 PM–4:42 PM	Mile High Ballroom 1F	Andrew Ye	**U53.00012**	**Now U53.11**

http://meetings.aps.org/Meeting/MAR20/Session/R46.3

Abstract: R46.00003 : Magnetic Excitations of the Frustrated Triangular Ising Magnet FeI2*

8:24 AM–8:36 AM
Room: 708

Authors:
Xiaojian Bai
(School of Physics, Georgia Institute of Technology)

Shang-Shun Zhang
(Department of Physics and Astronomy, University of Tennessee, Knoxville)

Zhiling Dun, Martin Mourigal
(School of Physics, Georgia Institute of Technology)

Hao Zhang, Haidong Zhou, Cristian Batista
(Department of Physics and Astronomy, University of Tennessee, Knoxville)

William Adam Phelan
(Department of Chemistry, Johns Hopkins University)

Matthew Stone, Alexander Kolesnikov, Feng Ye
(Neutron Scattering Division, Oak Ridge National Laboratory)

We present a detailed investigation of the spin dynamics in single-crystals of the layered spin-one triangular-lattice compound FeI2. Previous thermo-magnetic measurements revealed a strong Ising single-ion anisotropy for the Fe2+ ions in FeI2 and a magnetically long-range ordered state below 9.3K, which can be understood from the competition between nearest neighbor ferromagnetic interactions and a complex set of further-neighbor interactions. Early neutron scattering, far-infrared and ESR measurements, revealed the emergence of a two-magnon bound state (TMBS) as the lowest energy mode from this ordered state. The TMBS carries an apparent g-factor that is doubled compared to that of single magnon excitations, which can be explained by a change of 2 units in spin angular momentum, at odds with the dipole selection rule. We revisit the spin excitations of FeI2 using modern neutron-scattering instrumentation and map out the magnetic structure, diffuse scattering and low-energy magnetic excitation spectrum. We extract a model Hamiltonian for FeI2 and elucidate a novel hybridization mechanism that quantitatively explains current and previous spectroscopic experiments on this enigmatic compound.

*The work at Georgia Tech was sponsored by the Department of Energy under DE-SC-0018660.

Thursday, March 5, 2020

http://meetings.aps.org/Meeting/MAR20/Session/U61.7

Abstract: U61.00007 : Growth and Characterization of Heterostructures of Ferromagnetic $SrRuO_3$ and Superconducting Sr_2RuO_4 by Molecular-Beam Epitaxy

4:06 PM–4:18 PM
Room: Mile High Ballroom 4B

Authors:
Nathaniel Schreiber
(Cornell University)

Hari Nair, Jacob Ruf, Ludi Miao, Berit Goodge, Lena Kourkoutis, Kyle M Shen, Darrell Schlom
(Cornell University)

Sr_2RuO_4 single crystals have been shown to exhibit unconventional superconductivity with a T_c of 1.5 *K*. Our group recently reported a thermodynamic growth window for $Sr_{n+1}Ru_nO_{3n+1}$ thin films, including the demonstration of the reproducible growth of high-*RRR* Sr_2RuO_4 and $SrRuO_3$ thin films. The growth of Sr_2RuO_4 thin films and the recent ^{17}O NMR results on single crystals offer an opportunity for the growth of Sr_2RuO_4-based heterostructures, in order to perform measurements to determine the superconducting order parameter. In this talk, we describe the growth of $SrRuO_3/Sr_2RuO_4$ heterostructures using oxide molecular-beam epitaxy. We characterize the crystallinity and structure of these heterostructures using X-ray diffraction, X-ray reflectivity, and scanning transmission electron microscopy, and finally we present magnetometry and electrical resistivity measurements on these heterostructures.

Thursday, March 5, 2020

NOW: http://meetings.aps.org/Meeting/MAR20/Session/U53.11

Abstract: U53.00011 : Automated Vacuum Stacking for Additive Assembly of 2D van der Waals Heterostructures*

4:30 PM–4:42 PM
Room: Mile High Ballroom 1F

Authors:
Andrew Ye
(Pritzker School of Molecular Engineering, University of Chicago)

Andrew J Mannix
(James Franck Institute, University of Chicago)

Fauzia Mujid
(Department of Chemistry, University of Chicago)

Chibeom Park
(James Franck Institute, University of Chicago)

Jiwoong Park
(Pritzker School of Molecular Engineering, University of Chicago)

Wafer-scale synthesis of monolayer 2D materials (2DMs) address the stochastic, small-area limitations of micromechanical exfoliation. Using wafer-scale synthesized 2D semiconductors along with large-area patterning and multi-functional polymer stamps, we demonstrate a highly automated, dry-transfer, additive assembly process. Our high-vacuum system can assemble 2D heterostructures at the precision of actuator limits (few micron lateral/0.2° rotational). Identical structures have been assembled in parallel and stacks of high layer counts (25+) have been achieved, all without active user control of the system. Fabricated heterostructures include a range of 2DMs (MoS_2, WS_2, WSe_2, graphene) and metal electrodes (Au, Ti), and can be deposited onto a variety of substrates (SiO_2, Al_2O_3, 2DMs). We also demonstrate controlled twisted n-layer heterostructure assembly, where number of layers depends on area limits of single-crystal 2DMs growth.

*Work is supported by DoE EFRC NPQC & NSF PARADIM No. DMR-1539918. AY is supported by the DoD NDSEG Fellowship Program.

Friday, March 6, 2020

Time	Room	Presenter	Label	Updates
8:00 AM–8:36 AM	205	Derk Joester	**W18.00001**	
9:12 AM–9:24 AM	Mile High Ballroom 3B	Hari Nair	**W58.00007**	
9:48 AM–10:00 AM	703	Michael Matty	**W39.00009**	**New W39.8**
12:27 PM–12:39 PM	Mile High Ballroom 4C	Aaron Hui	**X62.00007**	

http://meetings.aps.org/Meeting/MAR20/Session/W18.1

Abstract: W18.00001 : Compositional and structural gradients in dental enamel: from nano- to microscale*

8:00 AM–8:36 AM
Room: 205

Presenter:
Derk Joester
(Northwestern University)

Authors:
Karen DeRocher, Paul JM Smeets
(Northwestern University)

Berit Goodge, Michael J Zachmann, Lena Fitting Kourkoutis
(Cornell University)

Prasanna Venkataraman Balachandran
(University of Virginia)

Linus Stegbauer, Michael Cohen, Lyle M Gordon, James Rondinelli, Derk Joester
(Northwestern University)

Dental enamel has evolved to bear large masticatory forces, resist mechanical fatigue, and withstand wear over decades of use. Functional impairment or loss, as a consequence of developmental defects or tooth decay, has a dramatic impact on health and quality of life. While the last decade has seen great progress in our understanding of enamel formation and the functional properties of mature enamel, attempts to repair enamel lesions or synthesize enamel in vitro have had limited success. This is partly due to the highly hierarchical structure of enamel and the additional complexities arising from chemical gradients that we are only beginning to understand. Herein we show, using atomic-scale quantitative imaging and correlative spectroscopies, that human enamel is comprised of crystalline apatite and a Mg-rich amorphous intergranular phase. Individual crystallites have core-shell structure. The core is comprised of two thin layers enriched in Mg flanking a region that is poor in Mg and enriched in Na. Fluoride is often also present in layers. The sandwich core is surrounded by a shell largely free of substitutional defects. A mechanical model of coherent crystallites based on DFT calculations predicts that significant residual stresses, with important implications for enamel dissolution, crystallite and tissue mechanical properties, and crystal growth processes during amelogenesis. In addition to these gradients at length scales from single digit to 10s of nanometers, we will report on systematic changes in average lattice parameters and coherence length across single enamel rods, i.e. length scales on the order of 1-10 µm.

*NIH-NIDCR R03 DE025303-01, R01 DE025702-01; NSF DMR-1508399; NSF PARADIM DMR-1539918; University of Virginia

Friday, March 6, 2020

http://meetings.aps.org/Meeting/MAR20/Session/W58.7

Abstract: W58.00007 : Manipulating superconductivity in Sr_2RuO_4 thin films through epitaxial strain

9:12 AM–9:24 AM
Room: Mile High Ballroom 3B

Authors:
Hari Nair
(Cornell University)

Nathaniel Schreiber, Jacob Ruf, Ludi Miao, Yawen Fang, Yonghun Lee, Brad J Ramshaw, Kyle M Shen, Darrell Schlom (Cornell University)

Mario Brützam, Christo Guguschev
(Leibniz-Institut für Kristallzüchtung)

Pushing the van Hove singularity in the γ band of Sr_2RuO_4 towards the Fermi level can potentially raise the transition temperature, T_c, of this unconventional superconductor. To test this concept, we explore the effect of biaxial strains from –0.9% to +1.0% imposed by commensurate epitaxy on $(NdAlO_3)_{0.39}$—$(SrAl_{1/2}Ta_{1/2}O_3)_{0.61}$ (NSAT), $NdGaO_3$, $(LaAlO_3)_{0.29}$—$(SrAl_{1/2}Ta_{1/2}O_3)_{0.71}$ (LSAT), $LaGaO_3$, and $SrTiO_3$ substrates on the superconducting T_c and upper critical field H_{c2} of Sr_2RuO_4 thin films. These biaxial strain studies are distinct from and compliment the existing uniaxial strain studies on Sr_2RuO_4 single crystals. Mean free paths up to 144 nm are observed in Shubnikov-de Haas oscillation measurements on these thin films and T_cs range from 1 K to 1.8 K for films with similar residual resistivities. The measured mean free paths in combination with the coherence lengths, determined from upper critical field measurements, established that all films are superconducting in the clean limit.

Friday, March 6, 2020

NOW: http://meetings.aps.org/Meeting/MAR20/Session/W39.8

Abstract: W39.00008 : Transferable and interpretable machine learning model for four-dimensional scanning transmission electron microscopy data*

9:48 AM–10:00 AM
Room: 703

Authors:
Michael Matty
(Physics, Cornell University)

Michael Cao, Zhen Chen, David Muller
(Applied and Engineering Physics, Cornell University)

Li Li
(Google Research)

The challenge brought to scientific discovery by the data revolution may be overcome by data scientific approaches. Here we focus on 4D scanning transmission electron microscopy (STEM) data. With advances in detector technology, STEM records the full scattering distribution at each scan position in real space, producing a 4D phase-space distribution. An efficient approach is needed to turn these data into a real space image with subatomic resolution. Existing approaches are limited: annular dark field (ADF) imaging by low dose efficiency and resolution, and ptychography to a few atomic layers and by high computational cost. Here, we develop an efficient, interpretable machine learning model to map the entire STEM dataset to real space images. Our model has higher contrast than ADF, still distinguishes atomic species, and transfers well between samples of different lattice symmetry. We benchmark against conventional approaches using quantitative metrics for resolution and contrast.

***We acknowledge support from DOE DE-SC0018946, the Cornell Center for Materials Research with funding from the NSF MRSEC programme (DMR-1719875), and NSF (Platform for the Accelerated Realization, Analysis, and Discovery of Interface Materials (PARADIM)) under Cooperative Agreement No. DMR-1539918.**

Friday, March 6, 2020

http://meetings.aps.org/Meeting/MAR20/Session/X62.7

Abstract: X62.00007 : Quantum aspects of “hydrodynamic” transport from weak electron-impurity scattering*

12:27 PM–12:39 PM
Room: Mile High Ballroom 4C

Authors:
Aaron Hui
(Cornell University)

Samuel Lederer, Eun-Ah Kim
(Cornell University)

Vadim Oganesyan
(The Graduate Center, City University of New York)

Recent experimental observations of apparently hydrodynamic electronic transport have generated much excitement. However, theoretical understanding of the observed non-local transport (whirlpool) effects and parabolic current profiles has remained at the level of a phenomenological analogy with classical fluids. A more microscopic account of genuinely hydrodynamic electronic transport is difficult because such behavior requires strong interactions to diffuse momentum. Here, we show that the non-local conductivity effects can indeed occur for fermion systems in the presence of disorder. By explicit calculation of the conductivity at finite wavevector σ(q) for selected weakly disordered free fermion systems, we propose experimental strategies for demonstrating distinctive quantum effects in non-local transport at odds with the expectations of classical kinetic theory. Our results imply that the observation of whirlpools or other "hydrodynamic" effects does not guarantee the dominance of electron-electron scattering over electron-impurity scattering.

*AH was supported by the NSF Fellowship. E-AK was supported by the W.M. Keck Foundation. VO was supported by NSF DMR Grant No. 1508538. We acknowledge support from NSF through PARADIM under Cooperative Agreement No. DMR-1539918.