Summer 2014 Newsletter

DMP NEWSLETTER
Division of Material Physics

In this Issue

Dates to Remember

August 15, 2014 (Friday) Deadline for submitting invited speaker suggestions for DMP Focus Topics.
September 15, 2014 Nomination deadline for Richard L. Greene Dissertation Award in Experimental Condensed Matter Materials Physics.
November 14, 2014 (Friday) by 5pm EST. Abstract deadline for the 2015 APS March Meeting. Submission is via the web at http://abstracts.aps.org
February 1, 2015 DMP Deadline for APS Fellowship Nominations.
March 02 - March 06, 2015 (with tutorials, etc., March 01): APS March Meeting in San Antonio, Texas.

A Note from the Chair

I am delighted to extend a welcome to our Members of the Division of Materials Physics from our entire Executive Committee. This summer's Newsletter contains important information for the upcoming APS March Meeting, March 02 – 06, 2015, in San Antonio, Texas.

As in previous years, DMP is organizing interdisciplinary Focus Topics for the March Meeting that will cover many different facets of materials physics. Chair-Elect John Mitchell is coordinating the process, and all the members of the Executive Committee helped to select the topics and to invite the organizers. The Focus Topics are a major contribution of DMP to the March Meeting, and we encourage you to review the topics, suggest invited speakers to the organizers, and plan to submit contributed talks to the topics that overlap with your interests. These Focus Topic sessions are particularly beneficial to our younger members, as they can contribute in a session clustered around an invited speaker, which will not only provide added visibility, but also a consilience not always present in contributed sessions. We stress that your input of invited speaker suggestions is particularly important to the success of the meeting, so please do recommend speakers and any advice to the organizers of the various topics, which are listed here in this Newsletter.

This is the first year of the Richard L. Greene Dissertation Award in Experimental Condensed Matter Materials Physics. We are grateful for this philanthropic contribution by our colleague and expect to see many deserving candidates from which to choose (http://www.aps.org/programs/honors/dissertation/greene.cfm).

For those of you who have nominated candidates for the James C. McGroddy Prize for New Materials, and the David Adler Lectureship in Materials Physics, I thank you: Nominations are time consuming and take great deal of thought, and no one wins without nominations.

The DMP also recognizes the Young Scientist Prize in the Structure and Dynamics of Condensed Matter Physics. The International Union of Pure and Applied Physics (IUPAP), Commission 10, awards this prize and the winner is recognized with an invited talk in a DMP-sponsored Symposium, and at our Reception at the March Meeting.

Student presenters are invited to apply for a Stanford and Iris Ovshinsky Student Travel Award, available to students whose abstracts are placed in DMP-sponsored contributed sessions. Besides travel support, students are recognized in our Reception at the March Meeting. Information is included below.

We also encourage all members to plan nominations for APS Fellowship. The deadline this year is expected to be February 1, 2015, and starting early is encouraged. Detailed instructions are available on the DMP website.

Finally, I would like to take this opportunity to thank the members of the DMP Executive Committee who have recently completed their service, for the generous donation of their time and expertise in carrying out the work of DMP. These are: Charles Ahn and Bruce Harmon who have stepped down as Members at Large; and Chris Palmstrøm who completed two three-year terms as DMP Secretary-Treasurer. We give a special thanks to Darrell Schlom, who has completed four years of leadership as Vice-Chair, Chair-Elect, Chair, and Past-Chair of the Division of Materials Physics.

We look forward to seeing you in San Antonio!

Laura H. Greene, DMP Chair and APS Veep-elect.

The American Physical Society - Division of Materials Physics Ovshinsky Student Travel Awards

The Ovshinsky Student Travel Awards have been established to assist the career of student researchers. The Awards are named after Stanley and Iris Ovshinsky, who had a very strong interest and commitment to scientific education. The awards have been endowed by the Ovshinsky family, their colleagues at Energy Conversion Devices (ECD) companies and all their numerous friends from many social, intellectual and business relationships.

We anticipate that there will be ten $500 awards each year to enable students to participate in the APS March Meeting sessions, which are sponsored by the Division of Materials Physics. The selection will be based on merit and the committee will consist of the following officers of the Division of Materials Physics: Secretary/Treasurer, Vice Chair and Past Chair.

Students interested in being considered for an award must apply online at (to be updated).

The **Iris Ovshinsky Student Travel Awards** for the 2014 March Meeting were presented to: Matthew Brahlek (Rutgers University), Shun Chi, (University of British Columbia), Amanda Larson (Univeristy of New Hampshire), David Nieto Simavilla (Illinois Institute of Technology), Andrew O'Hara (The University of Texas at Austin), Justin Song (Harvard University and MIT), Joonki Suh (University of California, Berkeley), I-Cheng Tung (Northwestern University).

The Richard L. Greene Dissertation Award in Experimental Condensed Matter Materials Physics

To recognize doctoral thesis research of exceptional quality and importance in experimental condensed matter or experimental materials physics. The award, to be given annually, will consist of $2500, a certificate citing the contributions made by the recipient, and an allowance of up to $1500 for travel to attend and give an invited talk at the annual APS March meeting at which the award will be presented.

The award was established in 2013 to honor the scientific and administrative contributions of Richard L. Greene to experimental condensed matter and materials physics. The Richard L. Greene Award is supported by a gift from his family.

Nominations will be accepted for doctoral dissertations written in English and submitted to any college or university, worldwide. Nominees must have submitted their dissertations after January 1, two years prior to the award. Nominations may be considered for up to two consecutive review cycles.
Nomination information: http://www.aps.org/programs/honors/dissertation/greene.cfm.

Pictures taken at the 2014 March Meeting Awards Reception

2014 Ovshinsky Student Travel Award winners together with Chris Palmstrøm (Secretary/Treasurer, left).

2014 APS-DMP Fellows Awards Recipients together with, Chris Palmstrøm (Secretary/Treasurer) and David Cahill (Chair).

Nominations for DMP Officers and Executive Committee Members

The DMP Officer election will be held late in 2014 to elect a Vice-Chair, and two new at-large Executive Committee Members. The Nominating Committee shall nominate at least two candidates for the ballot for each office. Suggestions for candidates can be made to the Chair of the Nominating Committee, David Cahill (d-cahill@uiuc.edu). In addition, candidates can be directly nominated to be placed on the ballot by petition of five percent of the membership of the Division. Such petitions must be received by the Secretary/Treasurer, Robert Nemanich (robert.nemanich@asu.edu) by September 13, 2014.

Call for Invited Speaker Suggestions

With this issue of the Newsletter, the Division of Materials Physics announces the program of DMP Focus Topics for the 2015 APS March Meeting (San Antonio, Texas, March 02 - March 06, 2015). A Focus Topic generally consists of a series of sessions, each of which is typically seeded with one invited talk, the remainder of the session being composed of contributed presentations.

August 15, 2014 is the deadline to submit suggestions for DMP Focus Topic invited speakers for the 2015 March Meeting.

For the 2015 March Meeting, DMP is the lead organization unit on 22 different Focus Topics and co-sponsoring unit for an additional 13. See lists below. DMP members are encouraged to make suggestions for invited speakers for these Focus Topics via the web --> http://go.aps.org/dmpinvited14

Your nomination will go to the organizers of the Focus Topic for which you have suggested a candidate and will aid the organizers in their selection of invited speakers. A complete listing of DMP-sponsored Focus Topics and their descriptions are given below.

In suggesting speakers please keep in mind that speakers who gave an invited talk at the previous March Meeting are ineligible.

Thank you in advance for your help in making the March Meeting a success.

Finally, note that the contents of this Newsletter will be available electronically on the DMP website at http://www.aps.org/units/dmp. Corrections or updates will also be posted at this location.

List of DMP-Sponsored or Co-Sponsored Focus Topics and Sorting Categories for the 2015 APS March Meeting

DMP led Focus Topics (submit invited talk nominations through DMP: http://go.aps.org/dmpinvited14)

3.1.1 Cooperative Phenomena in Plasticity (DMP)

Co-organizers: **Stephanos Papanikolau** (Yale University) stefanos.papanikolaou@yale.edu,
Dennis Dimiduk (Wright-Patterson Air Force Base) Dennis.Dimiduk@wpafb.af.mil,
Robert Maass (Institute for Materials Physics, Göttingen) robert.maass@ingenieur.de

The behavior of plastically deformed matter, either crystalline or structurally disordered in nature, is of both fundamental and practical scientific importance; e.g. the deep understanding of plasticity has led to the innovation of unconventionally strong but ductile and/or light nanostructured materials, hierarchical structures and metamaterials. Mechanisms of plastic deformation are typically understood with respect to well defined structural excitations (e.g. dislocations) that may extend up to a single or multiple length scales and evolve in a single or multiple time scales. Furthermore, these structural excitations may mutually interact, leading to emergent collective phenomena such as abrupt avalanches, non-local instabilities such as permanent slip-bands and complex grain substructures. While these phenomena are interesting in their own physical rights, they are at the core of non-trivial phenomena with singular technological importance: fatigue-driven fracture, size effects in micro and nano crystals, shear-band formation in bulk metallic glasses or polymers etc.
This focus topic, consisting of several invited and contributed sessions, will make an effort to build bridges between the physics and engineering communities by first putting the topic under the perspective of traditional plasticity understanding, and then assess recent theoretical, experimental and computational efforts towards the understanding of all the regimes where traditional views break down and the ways technology might use in order to build the strong, light and ductile materials of the future.

6.1.3 Strongly Spin-Orbit Coupled Materials (DMP)

Co-organizers: **Gang Cao** (University of Kentucky) cao@pa.uky.edu,
Warren Pickett (University of California, Davis) pickett@physics.ucdavis.edu,
Hidenori Takagi (University Tokyo and MPI Stuttgart) takagi@phys.s.u-tokyo.ac.jp

Strong spin-orbit coupling (SOC) in materials has become an active area of study, with much to be discovered and understood. Already it is fundamental to great activity in topological insulators, and the Rashba effect at surfaces and interfaces that is introducing new phenomena in relation to spintronics. The interplay of strong electronic correlations and large SOC is especially important in 5d materials, with Ir and Os ions attracting the most attention so far. The understanding of these materials requires a fundamental understanding of the new balance between SOC and other competing interactions including Coulomb interactions, crystal-field splittings, and exchange interactions. These competing energies can sometimes combine in unusual ways, as with the formation of the effective J=1/2 state in $5d^5$ configurations. Materials containing Ru^{4+}, Re^{3+}, Os^{4+}, and Ir^{5+} ions having d4 configuration are also drawing increasing attention; higher valence states also can be exciting. The scope of this Focus Topic will encompass 4d- and 5d-transition-metal compounds, rare earth compounds, and heavy chalcogenide compounds, as long as issues of strong SOC are central to the understanding of their behavior. These classes of materials exhibit a wide variety of interesting physical phenomena including metal-insulator transitions, Mott insulator formation, strong Rashba splittings, strong magnetic anisotropies, and superconductivity. The emphasis however will be on materials issues in keeping with the mission of DMP.

7.1.1 Dielectric and Ferroic Oxides (DMP/DCOMP)

Co-organizers: **Massimiliano Stengel (**Institut de Ciencia de Materials de Barcelona) mstengel@icmab.es,
Sang-Wook Cheong (Rutgers University) sangc@physics.rutgers.edu,
Venkatraman Gopalan (Penn State University) vxg8@psu.edu

Complex oxides exhibit a rich variety of order parameters, such as polarization, magnetization, strain, charge and orbital degrees of freedom. The vast range of functional properties that emerge from their mutual coupling (e.g., ferroelectricity, magnetoelectricity, multiferroicity, metal-insulator transitions) are the main topics of interest for this symposium. Examples of current grand challenges include: (i) Novel mechanisms to break inversion symmetry in heterostructures and layered oxides. (ii) Viable routes to achieve a strong coupling between polarization and ferromagnetism at room temperature. (iii) Band-filling and bandwidth control in complex oxides (a prerequisite to harnessing charge/orbital order, magnetic transitions and metal insulator transitions). (iii) Electric field control of these phenomena - a very exciting prospect for both fundamental science and technology. (iv) Structure and properties of magnetoelectric domains and domain walls of these materials. (v) Emerging avenues to controlling polarization, magnetism and electronic properties via strain and/or strain gradients (e.g. flexoelectricity). Breakthroughs and progress in the theory, synthesis, characterization, and device implementations in these and other related topics are solicited for this Focus Topic.

7.1.2 Topological Materials: Synthesis and Characterization (DMP)

Co-organizers: **Nitin Samarth** (Penn State University), nxs16@psu.edu,
Vidya Madhavan (Boston College) vidya.madhavan@bc.edu,
Joel Moore (UC Berkeley) jemoore@berkeley.edu

There has been explosive growth in the study of topological materials in which the combined effects of the spin-orbit coupling and fundamental symmetries yield a bulk energy gap with novel gapless surface states robust against scattering. Moreover, the field has expanded in scope to include topological superconductors, Dirac and Weyl semimetals, Kondo insulators and complex heterostructures capable of harboring exotic topologically nontrivial states of quantum matter. The observation of theoretical predictions depends greatly on sample quality and there remain significant challenges in identifying and synthesizing the underlying materials having properties amenable to the study of the surface and interface states of interest. This topic will focus on fundamental advances in the synthesis, characterization and modeling of candidate topological materials in various forms including bulk single crystals, exfoliated and epitaxial thin films, epitaxially modulated heterostructures, nanowires and nanoribbons, and theoretical studies that illuminate the synthesis effort and identify new candidate materials. Of equal interest is the characterization of these samples using structural, transport, magnetic, optical and other spectroscopic techniques, and related theoretical efforts aimed at modeling various properties and the underlying spin-textures, spin-splittings and substrate effects, with particular focus on identifying samples whose properties are dominated by the surface and interface states.

8.1.2 Dopants and Defects in Semiconductors (DMP/FIAP)

Co-organizers: **Len Brillson** (Ohio State University) brillson.1@osu.edu,
Shengbai Zhang (Rensselaer Polytechnic Institute) zhangs9@rpi.edu

Impurities and native defects profoundly affect the electronic and optical properties of semiconductor materials. Incorporation of impurities is nearly always a necessary step for tuning the electrical properties in semiconductors. In some cases, as in dilute III-V alloys, impurities even modify the band gap. Defects control carrier concentration, mobility, lifetime, and recombination; they are also responsible for the mass-transport processes involved in migration, diffusion, and precipitation of impurities and host atoms. The control of impurities and defects is the critical factor that enables a semiconductor to be engineered for use in electronic and optoelectronic devices as has been widely recognized in the remarkable development of Si-based electronics, the current success of GaN-based blue LED and lasers, and the emergence of ZnO for nanoelectronics sensors, and transparent conducting displays. The fundamental understanding, characterization and control of defects and impurities are essential for the development of new devices, such as those based on novel wide-band gap semiconductors, spintronic materials, and low dimensional structures.

The physics of dopants and defects in semiconductors, from the bulk to the nanoscale, including surfaces and interfaces, is the subject of this focus topic. Abstracts on experimental and theoretical investigations are solicited in areas of interest that include: the electronic, structural, optical, and magnetic properties of impurities and defects in elemental and compound semiconductors, SiO2 and alternative dielectrics, wide band-gap materials such as diamond including NV centers, SiC, group-III nitrides, two-dimensional materials including phosphorus and BN, oxide semiconductors, and the emerging organic-inorganic hybrid perovskite (e.g., $MAPbI_3$) solar cell materials are of interest. Likewise welcomed are abstracts on specific materials challenges involving defects, e.g., in processing, characterization, property determination, including imaging and various new nanoscale probes.

9.1.1 Fe-based Superconductors (DMP/DCOMP)

Co-organizers: **Peter Hirschfeld** (University of Florida) pjh@phys.ufl.edu,
Qiang Li (Brookhaven National Laboratory) qiangli@bnl.gov,
Greg Stewart (University of Florida) stewart@phys.ufl.edu

Substantial experimental and theoretical progress has been made toward understanding the unusual normal and superconducting state properties of iron based superconductors (IBS). Yet, many challenges and controversies exist, often driven by recent discoveries of new or improved materials whose properties differ radically from the original set. This Focus Topic will cover the latest experimental and theoretical issues pertaining to the normal and superconducting properties of IBS and their parent compounds, both pnictide and chalcogenide based. By better understanding the relationship between these two families, and how the different crystalline, magnetic and electronic structures in IBS relate to the high critical temperatures, the goal is to cultivate the potential for discovering new superconducting systems and higher T_c values.

9.1.2 Search for New Superconductors (DMP)

Co-organizers: **Kyle Shen** (Cornell University) kmshen@cornell.edu,
Pengcheng Dai (Rice University) pd20@rice.edu

The search for new superconducting materials and/or the enhancement of existing superconductors remains one of the most important challenges in modern condensed matter physics. This is of crucial importance for not only understanding the fundamental nature of exotic superconducting states but also to fulfill their promise for widespread applications. This topic will focus on recent advances in the synthesis, characterization, and predictions of new superconductors, as well as approaches to optimizing the properties of materials such as but not restricted to iron-based and cuprate superconductors. Exploratory investigations of materials with promising structural or electronic motifs are encouraged, along with progress in the synthesis and characterization of existing compounds. New tools and approaches for characterizing and detecting superconductivity are also of particular interest. In addition to bulk materials, we will also focus on thin films and heterostructures grown using techniques such as pulsed laser deposition and molecular beam epitaxy which allow for the creation of atomically precise heterostructures which might enhance superconductivity (e.g. monolayer FeSe / $SrTiO_3$) or metastable compounds.

9.1.3 Engineering Vortex Matter (DMP)

Co-organizers: **David Larbalestier** (Florida State University) larbalestier@asc.magnet.fsu.edu,
Wai-Kwong Kwok (Argonne National Laboratory) wkwok@anl.gov

To achieve transformational breakthroughs in superconductor performance, there is a need to understand and control vortex matter. The behavior of vortex matter is responsible for the entire electromagnetic behavior of applied superconductors. This focus topic will highlight recent advances in engineering vortex matter in films, wires and crystals via self-organized defects, magnetic pinning, nanofabrication and other mixed pinning landscapes to enhance their critical current and to produce novel controlled behavior such as ratcheting, self-adaptive pinning, reduced anisotropy and jamming, among others. In addition, theoretical modeling and predictions of novel vortex matter behavior through Monte Carlo and time dependent Ginzburg-Landau simulations will also be highlighted. This session will address experimental, computational, and theoretical directions in the pursuit of 'vortex behavior by design' in cuprates, Fe-based superconductors and other conventional, unconventional, and multiband superconductors.

9.1.4 Superconductivity in the two-dimensional limit (DMP)

Co-organizers: **Hanno Weitering** (University of Tennessee, Knoxville) hanno@utk.edu,
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Paul Snijders (Oak Ridge National Laboratory) snijderspc@ornl.gov

Thanks to the ever increasing sophistication of materials synthesis, it is now evident that superconductivity can be remarkably robust even in the extreme two-dimensional (2D) limit. Superconducting ordering temperatures in the 2D limit may even exceed those of the bulk by a significant margin, as was shown recently for single-layer FeSe. In all cases, 2D materials need a substrate for support, and the coupling to (or perturbation by) the substrate will affect the superconducting properties of these materials, thus carrying a promise of interface engineering of superconductivity and superconducting device miniaturization. From a fundamental perspective, the role of magnetic fluctuations or substrate phonons in Cooper pairing in atomic sheet materials are interesting propositions, and possible harmonies with concepts from e.g. high Tc cuprate studies and recent studies of topologically non-trivial materials could significantly advance our understanding and control of 2D superconductivity. This focus topic, consisting of several sessions with both invited and contributing speakers, attempts to create an atmosphere conducive to a meeting of the minds in these fields. We invite theoretical and experimental contributions with a clear focus on the fundamental physics of low-dimensional superconductivity and on the materials aspects of superconducting sheet materials. Examples include but are not limited to superconductivity in monatomic metal films on semiconductors, chalcogenide sheets, silicene, or in a 2D electron gas at the interface of insulating oxide materials.

12.1.1 Graphene: Synthesis, Defects, Structure, and Properties (DMP)

Co-organizers: **Phillip N. First (**Georgia Institute of Technology) first@physics.gatech.edu,
Joshua Robinson (Penn State University**)** jrobinson@psu.edu

Graphene has been proposed for a range of applications that exploit it's unique chemical, mechanical, and electronic properties. However, a great deal of science remains to be done on the path to practical technologies. Keys to progress are the synthesis of high-quality materials, the understanding and control of defects, and the characterization of both intrinsic properties and those stemming from interfaces with other materials. Scalable growth techniques for single-layer and few-layer graphene, such as epitaxial growth on SiC and chemical vapor deposition on a variety of substrates, are of growing interest. Meanwhile, the creation of nearly ideal nanostructures through templated or bottom-up growth promises new science beyond the quantum limit. This graphene focus topic will cover:

- experimental, theoretical, and computational studies illuminating various aspects of the growth process including, e. g., layer number and stacking geometry control, the formation of topological and structural defects, grain size and grain boundary control, and the effect of substrate chemistry, crystallography and strain
- methods of doping
- templated or bottom-up growth of nanostructures and integration with other materials
- characterization and modeling of the structural, mechanical, electronic, and optical properties of the synthesized graphene, and
- methods for transferring synthesized graphene to other substrates and the impact of the transfer process.

12.1.2 Two-Dimensional Materials and Devices Beyond Graphene: Focus on Semiconductors (DMP)

Co-organizers: **Wenjuan Zhu** (University of Illinois) wjzhu@illinois.edu,
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The rapidly expanding research on new 2D materials, many of which are semiconductors, has uncovered very diverse, often complementary properties to graphene. These promising 2D semiconductors need to be synthesized, explored and structured for devices, including integrating them with graphene. This Focus Topic will cover experimental and theoretical/computational work related to "beyond-graphene" 2D materials that are normally semiconductors, such as many chalcogenides (e.g., MoS_2, WSe_2, GaSe etc.), silicene, germanane, stannanane, and phosphorene. Topological insulators (e.g., Bi_2Se_3 or Bi_2Te_3), as well as large gap materials such as h-BN. Important areas of interest include determining and tuning the band structure and the resulting electronic and optical characteristics for monolayers, few-layers and heterostructures; understanding the role of the dielectric environment, many-body effects, and applied fields; thermal and mechanical properties; and materials synthesis, fabrication and integration for devices and applications.

12.1.3a Graphene Devices: Function, Fabrication, and Characterization (DMP)

Co-organizers: **Xu Du** (Stony Brook) xudu@notes.cc.sunysb.edu
Kirill Bolotin, (Vanderbilt), kirill.bolotin@vanderbilt.edu,
Vincent Meunier (Rensselaer Polytechnic Institute) meuniv@rpi.edu

The unprecedented range of spectacular electronic, structural, and transport properties of graphene has spurred a great deal of excitement and has prompted much hope in graphene's potential use for device applications. To achieve this goal, a number of challenges need to be tackled, both on improving the understanding of graphene's intrinsic properties and on solving practical difficulties related to integrating graphene with practical systems. This Focus Topic relates to experimental and theoretical studies of devices based on single- and multi-layered graphene. The graphene systems considered include but are not limited to electronic, optical, mechanical, thermal, and chemical structures and assemblies. We invite contributions on topics including: (i) the synthesis, fabrication, measurements, and modeling of graphene devices, (ii) proof-of-principle studies highlighting the promises of graphene for device applications, and (iii) interfacial, environmental, system-based analysis inherent to the practical use of graphene in future electronics.

12.1.3b Two-Dimensional Materials and Devices Beyond Graphene: Focus on Metals, Superconductors, and Correlated Materials (DMP)

Co-organizers: **Yong P. Chen** (Purdue University) yongchen@purdue.edu,
David Cobden (University of Washington) cobden@uw.edu

Research exploring 2D materials beyond graphene is rapidly expanding to include a wide variety of layered material systems with diverse properties. There is enormous interest in building functional materials, structures and devices based on these 2D materials, including their integration with graphene. The isolation and synthesis of these novel 2D materials has become an important area of materials physics research. This Focus Topic will cover experimental and theoretical/computational work related to "beyond-graphene" 2D materials that are normally metallic, superconducting, magnetic, or insulating, including many layered chalcogenides (eg. $NbSe_2$,TaS_2, FeSe) and oxides (eg. BSCCO). Many of these materials also have other correlated electronic phases such as charge or spin density waves, Mott insulators, etc. All electronic, thermal, magnetic, and optical properties and functions of monolayers, few-layers and heterostructures of these materials are of interest. Material synthesis, fabrication and integration are also included, as well as devices and applications exploiting their unique properties.

12.1.4 Carbon Nanotubes and Related Materials: Synthesis, properties, and Applications (DMP)

Co-organizers: **Zhihong Chen** (Purdue University) zhchen@purdue.edu,
Andrew Rinzler (University of Florida) rinzler@phys.ufl.edu

Interest in the fundamental properties and applications of carbon nanotubes and related materials remains high. This is because of their unique combination of electrical, chemical, mechanical, thermal, optical, spectroscopic and magnetic properties. This focus topic addresses recent developments in the fundamental understanding of nanotubes and related materials, including synthesis, characterization, processing, purification, chemical, mechanical, thermal, electrical, optical, and magnetic properties. This session will highlight how these properties lead to new fundamental physical phenomena and existing or potential applications for interconnects, transistors, thermal management, composites, super-capacitors, nanosensors, nanoprobes, field emitters, storage media, magnetic devices, etc. Experimental and theoretical contributions are solicited in the following areas:

- Synthesis and characterization of nanotubes, nanohorns, nanocones, and related nanostructures;
- Control or optimization of growth, including helicity control and in-situ studies;
- Purification, separation, chemical functionalization, alignment/assembly;
- Structure and properties of hybrid systems, including filled and chemically modified carbon nanotubes and nanotube peapods;
- Mechanical and thermal properties of these nanostructures and their composites;
- Electrical and magnetic properties of these systems;
- Mesoscopic, structural, optical, opto-electronic and transport properties as well as their spectroscopic characterization.
- BN and other inorganic nanotubes; other 3D forms of sp^2-carbon
- The focus topic will also cover the broad applications of these nanosystems, including:
- Electronic devices including interconnects, supercapacitors, transistors, memory;
- Thermal management applications;
- Multifunctional nanotube composites;
- Chemical and bio-sensing applications;
- Field emission;
- New generations of magnetic and electronic devices.

12.1.5 Van der Waals Bonding in Advanced Materials (DMP)

Co-organizers: **Noa Marom** (Tulane) nmarom@tulane.edu,
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Van der Waals interactions are ubiquitous in nature and play an important role in the structure, stability, and function of molecules and materials studied across all of the major disciplines of science, ranging from structural biology to supramolecular chemistry and condensed matter physics. These non-bonded interactions are inherently quantum mechanical phenomena resulting from dynamical correlation among collections of electrons, and remain a substantial challenge to date for both accurate first-principles theoretical calculations and direct experimental characterization. Hence, the aim of this Focus Topic is to directly address this challenge by highlighting the current state-of-the-art in both the theoretical description and experimental measurement of van der Waals interactions in materials of interest. In doing so, we hope to bridge the gap between theory and experiment, thereby laying the groundwork for future collaborative research - an approach that is necessary for describing these fundamental interactions in materials of increasing complexity. We also hope to strengthen links between the communities specialized in quantum chemistry, solid-state many-body theory, and Casimir physics.

12.1.6 Computational Discovery and Design of Novel Materials (DMP/DCOMP)

Co-organizers**: James Rondinelli** (Drexel University) jrondinelli@coe.drexel.edu,
Chris Pickard (University College London) c.pickard@ucl.ac.uk

Advances in theoretical understanding, algorithms and computational power are enabling computational tools, which play an increasing role in materials discovery, development and optimization. For example, recently developed data mining (informatics) techniques, (un)supervised learning, and global exploration routines of energy landscapes enable the "virtual synthesis" of novel materials, with their properties being predicted in advance of laboratory synthesis. This focus topic will cover recent methodological developments and applications at the frontier of computational materials discovery and design, ranging from quantum-level prediction to macro-scale property optimization. Of particular interest are computational and theoretical studies that feature a strong connection to experiment and apply novel approaches to materials design using data/computation-intensive paradigms. Topics include, but are not limited to, first principles materials discovery, algorithms to search structure/composition design space, data-mining techniques, innovations that improve the scope, accuracy, and efficiency of computational materials discovery and design, and applications ranging from low-power electronics (Mottronics), energy conversion and storage materials (thermoelectrics, batteries, fuel cells, photovoltaics), to novel materials for non-linear optics and data processing (spintronics).

13.1.1 Nanostructures and Metamaterials (DMP)

Co-organizers: **Andrea Alu** (University of Texas, Austin) alu@mail.utexas.edu,
Oded Rabin (University of Maryland) oded@umd.edu,
Rashid Zia (Brown University) rashid_zia@brown.edu

Recent experimental and theoretical advances have enabled the design and realization of nanostructured materials with complex and unusual electromagnetic properties. Such metamaterials and nanostructures provide unique opportunities to manipulate electromagnetic radiation over a broad range of frequencies, from the visible and infrared to terahertz and microwaves. This focus topic will highlight recent progress in the physical understanding of these designer materials. Topics of interest include, but are not limited to: metasurfaces, nanophotonics, plasmonics, and quantum optics, particularly those that explore novel effects such as extrinsic chirality, nonlinearity, nonreciprocity, and parity-time symmetry.

13.1.2 Engineering Phase Transitions in Strongly Correlated Oxides (DMP)

Co-organizers: **Emil Bozin** (Brookhaven National Laboratory) bozin@bnl.gov,
Stephen Wilson (Boston College) Stephen.wilson@bc.edu

Controlling and understanding emergent phase phenomena in strongly correlated oxide and other correlated quantum systems remain at the forefront of materials research and discovery. Robust and nearly equivalent coupling strengths between electronic and lattice degrees of freedom in these materials results in highly variable electronic properties and competing interactions coupled to either long-range or local symmetry breaking which often change dramatically with small perturbations to the system. Exotic metal-insulator transitions, high temperature superconductivity, ferroelectricity, colossal electronic susceptibilities, and new phases stabilized via cooperative correlation and spin-orbit effects offer just a few examples of electronic responses at this continuing materials frontier. The ability to probe, understand, and ultimately control the electronic ground states of these systems requires knowledge of interactions and symmetries across a broad range of length scales as well as dynamics spanning multiple time scales. Controlling these systems requires creative approaches to engineering both bulk crystalline and thin film materials such as manganites, ruthenates, and iridates via techniques spanning from strain/interface engineering to direct chemical substitution. This combined with recent advances in probing both the structures and dynamics at variable length/time scales allows for unparalleled insights into the origin of complex and important emergent
phenomena in strongly correlated systems.

13.1.3 Electron, Ion, and Exciton Transport in Nanostructures (DMP)

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Understanding the transport of electrons, ions, and excitons in nanostructures is critical for realizing the potential of nanoscience and next generation device technologies. Of particular challenge, and opportunity, for understanding transport in nanostructures is the impact of interfaces, shapes, electronic confinement, interactions and quantum effects. This is particularly true of hybrid, complex nanomaterials of different compositions and phases that can have varying degrees of electronic and optical couplings and interactions. Depending on the composition and geometry, couplings (electromagnetic, Coulomb, ballistic, tunnel, etc) can be weak or strong. Structural components used in hybrid nanostructures can be made of semiconductors, metals, molecules, liquids, etc. Correspondingly, elementary excitations responsible for optical and transport responses of such nanostructures include excitons, plasmons, electrons and ions.

Contributions are solicited in areas that reflect recent advances in experimental characterization and theory of transport mechanisms in inorganic and hybrid nanoscale structures. Specific topics of interest include, but are not limited to:

- Excitonic nanomaterials with light-harvesting and lighting properties utilizing both solid-state and molecular components
- Plasmonic nano- and meta-structures for light harvesting and concentration
- Hybrid structures with interacting exciton and plasmon resonances
- Energy transfer in hybrid nanomaterials including dots, wires, plates, polymers, etc
- Charge and exciton transport through metal-semiconductor interfaces
- Ultrafast dynamics of charge and exciton transport in nanostructures and across nanoscale interfaces
- Dynamics of energy and charge flow in nanostructured hybrid materials
- Hybrid nanomaterials for photo-catalytic applications utilizing excitons and plasmons
- Nanomaterials with bio-sensor properties
- Externally driven nanomaterials interacting with bio-matter
- Theoretical models of hybrid nanostructures with migration of charge and energy
- Experimental and theoretical correlation of nanoscale structure with electronic transport properties.
- Influence of dimensionality on charge and exciton transport

13.1.4 Complex Oxide Interfaces and Heterostructures (DMP)

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Complex oxide heterostructures display a range of impressive multi-functionality, encompassing superconductivity, colossal magnetoresistance, magnetism, multiferroicity, and strongly correlated Mott-Hubbard insulator-type behavior in addition to novel interface-stabilized ground states such as two-dimensional electron gases (2DEGs), 2D superconductivity, novel magnetism, and topological phases. The extreme sensitivity of these phenomena to composition and interface structure offers endless possibilities for fundamental studies of the interactions between the structural and electronic degrees of freedom that give rise to these fascinating phenomena, and thus providing many insights into materials physics in addition to the capability to design completely new devices. Local symmetry breaking, charge transfer, magnetic and electrostatic interactions, and coupling between structural modes are just some of the many mechanisms that can lead to the appearance of novel interfacial functionalities and can be employed for rational design of artificial materials with desirable structural, electronic and magnetic properties.
The aim of this focus session is to provide a forum for the discussion of recent experimental and theoretical results on complex-oxide heterostructures and their interfaces. The topics covered in this session will include advances in the growth and characterization of complex-oxide heterostructures, development of interface-related measurement techniques, theory and modeling of oxide heterostructures and interfaces, experimental investigation and tuning of interface-related properties in conducting, insulating and magnetic oxides, applications based on interface-related phenomena in complex-oxide heterostructures, and new phenomena appearing in complex oxides due to heterostructuring.

13.1.6 Thermoelectric Phenomena, Materials, Devices, and Applications
(DMP/GERA/FIAP/DCOMP)

Co-organizers: **Jihui Yang** (University of Washington) jihuiy@uw.edu,
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Thermoelectrics have emerged as a new frontier of materials research for energy conversion applications, with the dramatic increases in ZT over the past twelve months adding to the excitement. Physics associated with charge carrier, spin, photon, and phonon transport is of particular interest. This focus topic addresses recent developments in the fundamental understanding of thermoelectric materials, including theory, synthesis, characterization, processing, mechanical, thermal, and electrical properties. This sessions will also highlight the latest application advances in waste heat recovery, high efficiency heating/cooling, and how application related requirements lead to new avenues of fundamental research. Both Experimental and theoretical contributions are solicited.

13.1.7 Mesoscopic Materials and Devices (DMP)

Co-organizers: **Doug Natelson** (Rice University) natelson@rice.edu
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This Focus Topic is the study of mesoscale materials, systems in the regime where classical, microscale and nanoscale science meet, and mesoscale physics is critical to the system properties. It spans two areas: (i) facilities and tools needed to make, characterize and describe mesoscale materials, and (ii) new mesoscale phenomena and functionality. In particular, contributions describing new results in the following areas are solicited:

- Mesoscale synthesis: For example, lithographic techniques based on high-resolution electron beams, scanning- force-microscopy (SFM), and imprinting; SFM-stimulated growth; self-assembly; focused ion beam (FIB) manufacture; electron-beam-induced deposition (EBID); and ion-beam-induced deposition (IBID).
- Mesoscale characterization: Some examples are ballistic-electron emission microscopy (BEEM), SFM, optical microscopy and spectroscopy, tunneling spectroscopy, transport properties and electro-luminescence studies in small structures.
- Mesostructures and devices: This includes quantum wires and dots; mesoscale FETs and single-electron transistors (SETS); photonic and plasmonic structures; ferromagnetic, multiferroic, and spin-based devices; superlattice arrays; new developments in single and bilayer graphene, topological states of matter at the mesoscale; molecular electronic systems; and meso-electromechanical devices.
- Correlated electron systems at the mesoscale: Relevant phenomena include, non-equilibrium transport, instabilities; competition between phases at the mesoscale;,and quantum critical phenomena in metallic systems.

Quantum coherence at the mesoscale: The systems include the quantum Hall effect in mesoscale devices; ballistic quantum systems; quantum chaos; quantum-computing implementations and theory, phase coherence and breaking of coherence in electronic

DMP Co-Sponsored Focus Topics led by other APS Units (submit invited talk nominations through listed Unit)

01.1.8 Organic Electronics and Photonics (DPOLY/DMP)

10.1.1 Magnetic Nanostructures: Materials and Phenomena (GMAG/DMP)

10.1.2 Emergent Properties in Bulk Complex Oxides (GMAG/DMP)

10.1.3 Magnetic Oxide Thin Films and Heterostructures (GMAG/DMP)

10.1.4 Spin Transport & Magnetization Dynamics in Metal Based Systems (GMAG/DMP/FIAP)

10.1.5 Spin Dependent Phenomena in Semiconductors (GMAG/DMP/FIAP)

10.1.6 Frustrated and Low Dimensional Magnetism (GMAG/DMP)

10.1.7 Spin-Dependent Physics in Carbon-Based Materials (GMAG/DMP)

10.1.8 Low-Dimensional and Molecular Magnetism (GMAG/DMP)

16.1.5 Materials in Extremes: Bridging Simulation and Experiment (DCOMP/DMP)

16.1.6 Simulations of Matter at Extreme Conditions (DCOMP/GSCCM/DMP)

16.1.7 Non-Adiabatic Dynamics in Irradiated Materials (DCOMP/DMP)

16.1.11 Materials for Electrochemical Energy Storage (GERA/DMP/FIAP/DCOMP)