

DPOLY Sorting Categories and Focus Sessions (APS 2010)

4.0 Polymer and Soft Matter Physics

- 4.1 Semi-Crystalline Polymers
- 4.2 Liquid Crystalline Order in Polymer and Complex Fluids
- 4.3 Polymeric Glasses
- 4.4 Polymer Melts and Solutions
- 4.5 Elastomers and Gels
- 4.6 Charged and Ion-Containing Polymers
- 4.7 Physics of Copolymers
- 4.8 Polymer Blends
- 4.9 Polymer Composites
- 4.10 Electrically and Optically Active Polymers
- 4.11 Surfaces, Interfaces, and Polymeric Thin Films
- 4.12 Friction, Adhesion, and Fracture of Polymers
- 4.13 Biopolymers Molecules Solutions, Networks, and Gels
- 4.14 New Experimental, Theoretical, and Computational Methods in Polymer and Soft Matter Physics

Focus Sessions

4.15.1 Crystallization in Confined Geometry

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Polymer crystallization in a confined geometry offers a unique opportunity for understanding the effect of restricted chain conformation on crystallization behavior and has recently become a central focus in polymer crystallization research. This focus session covers recent developments in this field. Potential topics in this focus session include, but are not limited to, the following studies: polymer crystallization in 1D, 2D, and 3D confined space including structural, morphological, and crystallization kinetics changes; soft- and hard- confinement on polymer crystallization; crystalline block copolymers; epitaxy, graphoepitaxy and soft epitaxy; ultra-small polymer crystals; polymer crystallization in nanofibers; and crystallization in hybrid systems. Both theoretical and experimental studies are welcome.

4.15.2 Relaxation Dynamics of Polymeric Glasses

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The glass transition is one of the most important transitions exhibited by condensed matter, yet a fundamental understanding of this phenomenon remains elusive. It is nonetheless clear that polymeric, and other glass-forming liquids, exhibit large fluctuations in particle mobility/ local

stiffness and emergent collective motion and that this “dynamic heterogeneity” is somehow linked to the characteristic pattern of relaxation dynamics found in these fluids. This session will focus on specific experimental and computational evidence, as well theoretical models, quantifying the geometrical and temporal nature of this dynamic heterogeneity, factors that modify this heterogeneity (solvent and nanoparticle additives, film formation, pressure, molecular structure variation, mechanical deformation) and efforts to quantitatively relate this heterogeneity to relaxation in glass-forming materials. Studies of this kind for any type of structural glass-forming liquid are welcome.

4.15.3 Dynamics of Polymers and Complex Fluids

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This focus topic covers experimental, theoretical, and computational advances in the understanding of the molecular and structural dynamics of polymer solutions, melts, and related complex materials, such as liquid crystalline polymers, block copolymers, blends, polymer, and gels. Experimental techniques can include rheology, light, neutron, and x-ray scattering, dielectric spectroscopy, NMR, microscopy, and other techniques that probe dynamics or the effects of dynamic processes. Theories and simulations directed at the molecular and super-molecular levels that address dynamics ranging from segmental motion to the continuum level are invited.

4.15.4 Polymer Network Mechanics

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Polymer networks are actively studied for their potential to balance specialized functionality, e.g. biocompatibility, electronic conductivity, with mechanical integrity. Although the generalized theory of rubber elasticity is one of the classical examples of building molecular scaling arguments to describe quantitatively mechanical behavior, current research in dry and swollen networks has demonstrated the inability to predictably describe the hierarchical development of materials properties in complex network topologies. This focus topic covers recent developments in experiments, theory, and simulations for describing the mechanical response of polymer networks. Contributions are solicited on the following topics: elasticity and fracture of swollen gels, interpenetrated network properties, mechanics of charged gels, role of non-bonded interactions in network stress, monomer packing in polymer networks, and non-linear deformations in swollen and dry networks.

4.15.5 Hierarchically and Templated Ordered Systems

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Hierarchically and templated ordered systems are actively studied for their potential impact in a variety of fields including hybrid organic-inorganic materials, biomaterials, biosensing, tissue engineering, microelectronics, nanophotonics, data storage and alternative energies. These systems often offer unique alternative pathways for large scale precise manufacturing of materials, structures and devices without the need for highly complex and prohibitively expensive tools. Contributions are solicited on the studies of directed and templated assembling of block copolymers, peptides, nanoparticles, hybrid organic/inorganic structures, conjugated molecules, bio-molecules, fiber spinning, patterning and self-assembly related to fabrication and use of hierarchical ordered systems. Studies of physics of hierarchical organization of complex macromolecules and corresponding structures will be presented. Both theoretical and experimental studies are welcome.

4.15.6 Long Range Order in Polymeric Structure and Morphology

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Long-range order in polymer systems is important in applications such as lithographic patterning and photonics. This session will focus on efforts to characterize and improve the long-range order in polymeric systems in two and three dimensions. Both theoretical and experimental contributions are sought over a range of polymer systems including block copolymers, supramolecular polymers, semi-crystalline polymers, polymer blends, and polymer composites.

4.15.7 Thin Films Copolymers

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Thin films of copolymers are currently being investigated for widespread applications in which the nanoscale dimensions of the film morphologies are advantageous. This focus topic covers recent experimental and theoretical developments in designing, controlling, characterizing, or utilizing the nanostructured architectures of these materials. Contributions are solicited on, but are not limited to, the following topics: synthesis and assembly of new functional materials, directed assembly, thermodynamics and kinetics of thin film processing, and film structure-property relationships. Applications of the films that will be presented include patterning, membranes, electronics, photovoltaic devices, and photonics.

4.15.8 Polymer-Nanoparticle Interactions

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Hybrid materials with nanoparticles dispersed in polymers represent an exciting class of materials whose structure and properties can be controlled at the nanoscale. Principal challenges for developing technologies based on such materials include: i) design of building blocks with specific functionality, ii) controlling materials assembly, and iii) understanding structure-property relationships and the consequences of particle and polymer physics on such relationships. This session seeks papers addressing the fundamental experimental, theoretical and modeling elucidation of polymer nanoparticle interactions, NMR, x-ray, neutron and other spectroscopic techniques, and their impact on polymer physics and consequently the properties of such materials.

4.15.9 Physics of Polymer Nanocomposites

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There have been remarkable strides in facilitating the controlled dispersion of nanoparticles into polymer matrices, with the immediate goal of creating designer nanocomposites with "dialed-in" properties. Progress towards achieving these goals have been facilitated by new developments in synthetic chemistry (ATRP, RAFT, "click") that have permitted the functionalization of particle surfaces. Together with advances in theoretical modeling, processing and characterization has led to tremendous growth in the development of multifunctional materials. Presentations in this focus session will highlight the developments in this rapidly evolving field of polymer nanocomposites that promise to have dramatic impact on properties and applications.

4.15.10 and 16.12.6 Organic Electronics and Photonics (DMP/DPOLY/GERA)

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The electronic and photonic properties of organic materials, including small molecules and polymers, are subject of active fundamental and applied research. This focus topic covers the recent developments in this field.

Contributions are solicited on the following studies of organic semiconductors and related devices:

- a. charge carrier transport and injection
- b. optical properties
spectroscopy, physics of excitons, nonlinear optics, plasmonic effects in organic devices, lasing, and photonic bandgap materials
- c. energetics of organic-organic and organic-inorganic interfaces

Theoretical and experimental studies of device physics of organic field-effect transistors, photovoltaic cells, lasers, spin valves, and sensors are welcome.

4.15.11 Polymers and Energy: Photovoltaic, LED and Batteries (DPOLY/GERA/DMP)

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Polymers and Energy: Photovoltaic, LED and Batteries: Advances in development of polymeric materials and polymer based devices for energy applications have generated new knowledge, concepts and strategies for solar energy conversion, generation of light and energy storage. This symposium covers recent developments in this field. Contributions are solicited for research related to the above topics such as utilizing polymer – nanofiller, multijunction, multilayer based energy capture and conversion schemes, polymers as variable band gap materials, polymers in the capacity of light emitting and charge carrier transport materials and for energy storage device such as Lithium ion polymer batteries or block copolymers for ultracapacitors. Advances in physics underlying polymer enabled energy devices such as in solar cells, light emitting diodes, batteries and capacitors and their efficiency and performance is solicited through both theoretical and experimental studies.

4.15.12 Polymer Brushes

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The area of polymer brushes (or more generally, surface-anchored polymers) has recently received much attention, primarily because of new exciting opportunities in generating surfaces with well-defined and tailored physico-chemical characteristics. While many initial efforts in the field have concentrated on identifying the chemistries and assembly techniques leading to fabricating such systems, recent years have witnessed enormous boom in designing and developing practical applications utilizing the polymer brush platform. The purpose of this focus session is to bring together physicists and engineers working in the area of polymer brushes as well as those who are interested in employing this versatile materials assembly design in various areas of basic and applied research, including (but not limited to), controlling chemical (*i.e.*, wettability) and physical (*i.e.*, lubricity) characteristics. Applications relevant to energy harvesting and bio-related applications will also be highlighted. The latter topic will likely address the

generation of smart/responsive surfaces created on substrates having various geometries, including convex and concave, that impact research efforts in fabricating novel bioadhesion surfaces (*i.e.*, for affinity/interaction chromatographies) and selective separation media (*i.e.*, chemically-tailored membranes), respectively.

4.15.13 Glass Transition in Thin Films

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The glass transition in nanoconfined systems has been an active area of research for nearly two decades, with the multitude of perturbing influences on the nanoscale leading to a richness of phenomena that has far exceeded any expectations. These effects also have far reaching technological implications with glassy state properties and cooperative motion linked to ion conduction in polymer electrolyte membranes for use in batteries, gas transport in gas separation membranes and fuel cells, and in light-weight polymer nanocomposite systems. This focus topic will highlight recent developments in the field and strive to provide new ideas for future inquiry.

Both experimental and theoretical contributions are solicited on the nature of the glass transition in thin films and nanoconfined systems.

4.15.14 and 10.14.1: Single Molecule Biophysics (DCP/DPOLY/DBP)

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This focus session will bring together experimentalists and theoreticians, who use various single-molecule approaches to study the molecular mechanisms and discrete properties of RNA, DNA, proteins, and polymers in order to advance the knowledge on molecular and cellular biophysics. The focus session will cover a wide array of single-molecule techniques ranging from *in vivo* and *in vitro* fluorescence, atomic force microscopy and optical and magnetic tweezers, as well as theoretical approaches to analyze single-molecule data. This focus session will be useful to all who are interested in observing, manipulating, and elucidating the molecular mechanisms and discrete properties of biopolymers.

4.15.15 and 10.14.2: Biological-Synthetic Hybrid Materials (DPOLY/DBP)

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Controlled synthesis of nanoscale objects with sizes comparable to biomolecules opens new opportunities for the creation of hybrid materials incorporating both inorganic and biological elements on a basic structural level. These novel materials might utilize or mimic naturally

occurring processes and provide "smart" functional responses with potential applications in nano-architected devices, energy storage and conversion, biosensing, drug delivery, nano-optics and tissue engineering. In particular, the programmability of interactions and site-specific chemistry of biological entities, like DNA, RNA, peptides, and proteins, will enable a realization of the bottom-up approach for assembly of static and dynamic nanoscale systems. To unlock the potential of hybrid materials there is a need to understand self-organization, structure formation on various length scales, and emergent physical properties. We encourage experimental or theoretical contributions that contribute to the fundamental understanding or development and application of hybrid materials.

4.15.16 and 10.14.3: Synchrotron X-ray and Neutron Techniques in Soft Matter and Biological Physics (DPOLY/DBP)

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Synchrotron X-ray and Neutron techniques have enabled important advances in understanding the structure, kinetics, and dynamics of soft matter and biological physics. This focus topic will emphasize the most recent experimental developments in soft matter and biological physics using these techniques, as well as developments in the theory and analysis of scattering techniques and newly observed phenomena that have enabled quantitative interpretation of the data. Contributions are solicited that use any synchrotron X-ray or neutron technique to examine soft matter and biological physics, but novel techniques such as the following are of particular interest: Grazing incidence diffraction and small angle studies of thin films, membranes, interfaces, vesicles and other biologically relevant structures; X-ray photon correlation spectroscopy studies of dynamics in both reflection and transmission; neutron scattering studies using new capabilities such as 2-D detection, spin polarization, grazing incidence off-specular scattering, and novel techniques for enhancing reflectivity studies, such as spin echo labeling and TOF studies for following kinetics.

4.15.17: Multiscale Modeling in Polymer and Soft Matter Physics (DPOLY/DCOMP)

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Processes in polymeric and soft matter systems cover time scale intervals ranging from nanoseconds to seconds or even minutes. Thus, computer simulations of realistic polymeric and soft matter systems require covering the wide intervals in the time and the length scales. Even with the powerful supercomputers we have today, these could only be achieved by performing multiscale simulations that couple detailed molecular simulations with coarse-grained simulations of these systems in a self-consistent manner. The goal of this focus session is to bring together

physicists and engineers working in the area of computational polymer (polymer solutions, polymer melts and blends, and liquid crystals) and soft matter physics (gels, biological membranes, surfactant solutions, colloidal suspensions etc) as well as experimentalists who are interested in utilizing the advances of new computational techniques for analysis of the experimental data. The future developments in this fast growing field of polymer and soft matter physics could potentially lead to computationally assisted design of new materials.

4.15.18: Polymer Colloids (DPOLY/DCMP)

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Polymer colloid is a rapidly growing field of soft matter physics with applications ranging from drug delivery to design of photonic nanocrystals. Progress in this field depends on successful application of fundamental concepts of both colloidal and polymer physics. Contributions to this focus session are solicited in both experimental and theoretical studies of polymeric colloids including, but not limited to diffusion and mobility of colloidal particles in polymer solutions and gels, designing structures of colloidal aggregates by controlling interaction potential using grafted polymers and block copolymers, colloidal behavior of polymeric micelles and multi-arm stars.