



Notes from the Chair

In light of the tragic events of September 11, 2001, and the resulting developments, anything I could say as Chair of the MES Division would certainly seem trite. However, I feel all of us can contribute to the Nation's efforts by continuing to work and live normal lives without becoming paralyzed by our adversaries. If Americans could enhance their productivity by just 1%, this would go a long way to minimize the collateral impact of these attacks. Contributions from the members of the technological community such as members of MESD could be particularly significant. I cannot think of a better way for us to respond than by enhancing our contributions to our profession. Consequently, I urge all members of MESD to attend the Reno Meeting and to have an open exchange of technology with colleagues.

The results of this year's election show that highly qualified individuals continue to offer their time and service to the Division. I want to thank all the candidates for their participation and their continued service to MESD. For the first time, our elections were held electronically. If you did not receive an electronic ballot or had difficulty voting electronically, please contact Peter Gannon at AIChE (peteg@aiche.org). Results of the election are given below. Congratulations to our new officers, and thank you to all who volunteered as candidates. I look forward to seeing all of you in Reno.
-Larry Duda

Election Results

The election results have been compiled by the national office for the AIChE Division 8 (MESD) Board of Directors. We are pleased to welcome the following new members to the Board:

2 nd Vice Chair	Douglass Kalika
Directors	Donald Baird R.K. Krishnaswamy

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Charles M.A. Stine Award Lecture, 2000

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It is a great honor to receive the Charles M.A. Stine Award from the Materials Engineering and Sciences Division of AIChE. By sponsoring this award the DuPont Company, along with AIChE, acknowledges the important role of molecular-level engineering in the research and development enterprise that seeks to identify, prepare and utilize materials for the benefit of society. I am very grateful that the work of my research group at MIT has been acknowledged in this context. In the paragraphs that follow I describe briefly certain opportunities that arise for the preparation of nanocomposites using suitably functionalized block copolymers as templates materials.

Block Copolymers as Templates for Functional Materials

The ability to control both the length scale and the spatial organization of block copolymer morphologies makes these materials attractive candidates for use as templates in the synthesis of functional nanocomposites. Appropriate choices of the repeat units of the block sequences renders them capable of selectively sequestering preformed inorganic nanoclusters or selectively binding inorganic reagents for in-situ cluster synthesis. Methods exist to produce nanoscale voids which percolate through the structure, leading to processes

which coat or backfill the channels with functional materials. Applications in catalysis, magnetics, electro-optics and radiation filtering have been explored.

Block Copolymer Nanoreactors

There has been considerable attention given to the *in-situ* production of inorganic nanoclusters within the nanoscale-dimensional domains of a block copolymer morphology. Advantages of this approach include the elimination of preliminary steps to synthesize, stabilize and store the clusters, and the cumbersome mixing steps required to produce nanocomposite films with uniform dispersion. Furthermore, owing to the potential of achieving long range ordering of the block copolymer morphologies, patterned arrays of the clusters are readily achievable. In Figure 1, the spherical domain of a block copolymer contains receptor groups, capable of binding positive ions or positively charged fragments from labile organometallic species. Once loaded, the metal ions can be converted to oxides, selenides, sulfides or reduced to the zerovalent metal through exposure to the appropriate second reagent. Figure 1 shows the particular example of loading the nanoreactors with cadmium followed by H_2S treatment to form CdS clusters, confined within the block copolymer domain. The receptor sites are regenerated leaving the nanoreactors ready for further loading with the same or different reagents. Doped semiconductor clusters, metallic alloys, side-by-side cluster populations and core-shell structures can be made via this universal nanoreactor approach. Ciebien *et al.* 1998 have reviewed the block copolymer nanoreactor scheme from the perspective of in situ metal cluster production and the electrical and catalytic properties of the nanocomposite films.

In principle because the spherical domains of a typical block copolymer are generally very monodisperse in size distribution, the number of sequestering groups in every domain should be closely similar. This in turn should lead to single clusters in each domain, all clusters being of the same size. Although Chan *et al.* have managed to generate single, monodisperse silver clusters in certain circumstances, the more general case reveals

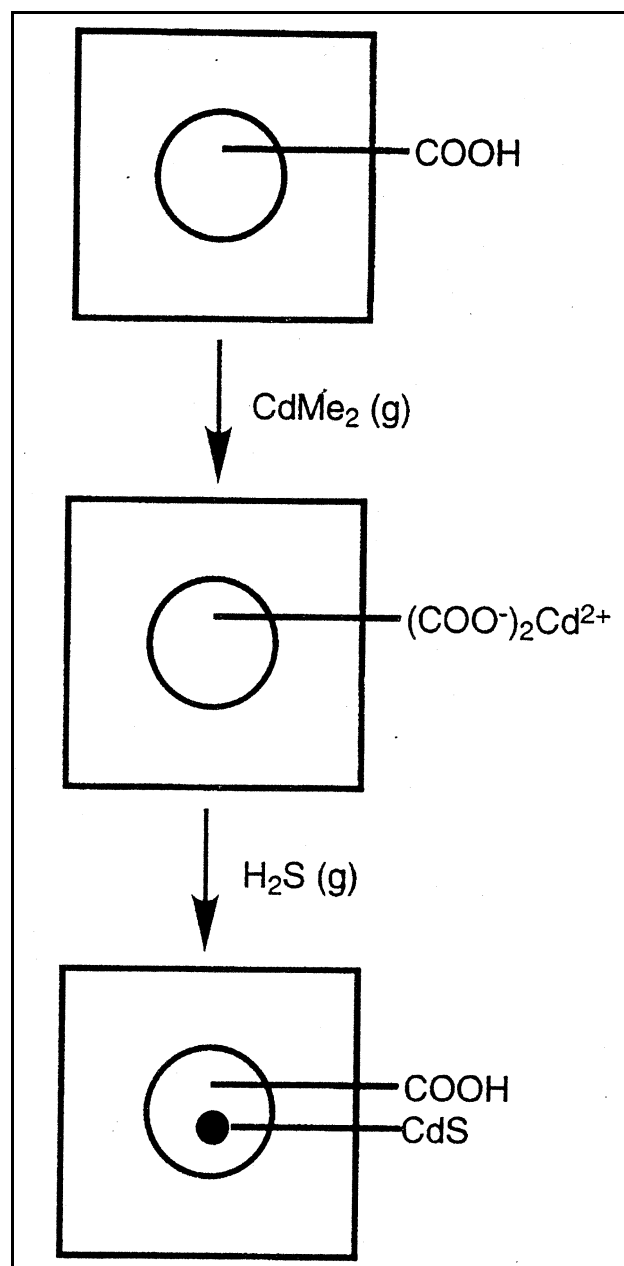


Figure 1 Schematic representation of the block copolymer nanoreactor approach to inorganic cluster synthesis.

multiple clusters across the domain of the nanoreactor. Issues of both thermodynamic and kinetic limitations on cluster growth in these copolymer films have been addressed by Kane *et al.*

In a second approach organometallic monomers are used to form one of the block sequences of the copolymer. Spontaneous ordering of the morphology

then amounts to the formation of pre-loaded nanoreactors ready for cluster forming chemistry. Advantages of this method include the elimination of any slow, potentially nonuniform and nonselective loading of the domains. The disadvantage of course is the requirement of a new organometallic monomer for each target application. Cummins *et al* have reviewed elements of this approach to cluster formation in block copolymers.

Self Assembling Block Copolymer Morphologies in the Presence of Preformed Inorganic Clusters

There are well known methods for producing monodisperse stabilized inorganic clusters (Murray *et al*) which can be stored indefinitely for later incorporation into polymer films. If there are groups in one of the blocks which are capable of displacing stabilizing species on the surfaces of the preformed nanoclusters, then the clusters would be expected to be selectively conveyed into this block domain during solvent processing of block copolymer films. A variation of this approach employs a derivatized center block of an ABC triblock copolymer to sequester preformed clusters to the interfaces between A domains in the continuous C matrix. Block sequences A and C could be suitably functionalized, for example comprised of hole conducting and electron conducting units respectively.

Nanoporous Block Copolymer Templates

Selective degradation of one of the block domains and subsequent removal of the degradation products creates a set of nanochannels in which functional inorganic materials may be grown selectively. In one elegant example Hashimoto *et al* 1997 selectively ozone-degraded the 1,4 polyisoprene domains of the bicontinuous gyroid morphology of a polystyrene-polyisoprene diblock copolymer. The resulting nanoporous structure was suitable for metal plating with Pd, Ni and Au. TEM examination of metal plated channels indicated that the metal plating process did not completely block the porosity of the final material, thereby making it

suitable for subsequent gas-solid catalytic reactions.

Applications

The utility of the block copolymer template approach lies in the spatial control and uniformity of dispersion of nanoclusters in a thin film or bulk specimen. Most applications envisioned for these nanocomposites are dictated by the functional nature of the clusters themselves. For example if permanent information storage is desired, magnetic clusters grown in the block copolymers must be large enough and possess the necessary magnetic anisotropy to retain indefinitely any imposed magnetization; on the other hand films containing very small superparamagnetic clusters have potential for use as optically transparent non-erasable magnetic watermarks. Similarly, electro-optical properties of the nanocomposite films such as the absorption edge for light transmission, its non-linear optical shift with light intensity and its light emission characteristics are largely dictated by the choice of clusters embedded in the films. However, it is possible to envision applications which capitalize on the ordered morphologies and chemical composition of the block copolymer template as well as the functional characteristics of the sequestered clusters. Catalytic membranes can be fashioned to exploit the selective gas transport characteristics of the domains of a dense diblock copolymer containing catalytically active clusters, facilitating both chemical reaction and product separation. Photovoltaic devices rely on separate channels for transport of holes and electrons away from an optically excited site, such as a semiconductor cluster.

The examples given above suggest that block copolymer templates may offer certain advantages over other methods of producing functional materials. Independent control over the physical and chemical nature of the constituent blocks, and the functional characteristics of the sequestered (or in-situ synthesized) inorganic clusters, provide a wide parameter space for the materials specialist seeking optimized materials for a variety of functional applications.

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Ekerdt Named 2001 Stine Award Recipient

John G. Ekerdt, Dick Rothwell Endowed Chair in Chemical Engineering and Department Chair at the University of Texas-Austin, has been named the 2001 recipient of the division's Charles M.A. Stine Award. Ekerdt earned his BS from the University of Wisconsin in 1974 and Ph.D. from the University of California at Berkeley in 1979. His research focuses on surface reaction kinetics, and the chemistry of electronic materials. Current programs include: growth and properties of barrier thin films; kinetics of silicon-germanium alloy epitaxy and nanoparticle growth from hydrides; and, organometallic precursor chemistry in thin film growth. John will give the Stine Award Lecture at 2:00 p.m. on Wednesday, November 7 at this year's Plenary Session at the Annual Meeting in Reno, NV.

Stine Award Recipients

Curry E. Ford (1979)
John L. Kardos (1981)
Alan S. Michaels (1982)
Nicholas A. Peppas (1984)
Donald R. Paul (1985)
Sheldon E. Isakoff (1986)
Stuart L. Cooper (1987)
Christopher W. Macosko (1988)
J. Larry Duda and James S. Vrentas (1989)
Curtis W. Frank (1990)
Robert S. Langer (1991)
Dale S. Pearson (1992)
Edward W. Merrill (1993)
Timothy J. Anderson (1994)
Klavs F. Jensen (1995)
Matthew V. Tirrell (1996)
Ilhan A. Aksay (1997)
Buddy D. Ratner (1998)
Dennis W. Hess (1999)
Robert E. Cohen (2000)
John G. Ekerdt (2001)

Plenary Session to be Held

The division's Plenary Session will be held at the Annual Meeting in Reno on Wednesday, November 7 in the Hilton Ballroom. The keynote speaker will be the 2001 Charles M.A. Stine Award winner, John G. Ekerdt, of the University of Texas at Austin, who will speak on "Chemical Vapor Deposition Epitaxy on Extended Surfaces to Nanocrystals on Dielectric Substrates."

Other speakers include Richard A. Register of Princeton University whose talk is entitled "Crystallizable Block Copolymers: Two Self-Organizing Mechanisms in a Single Material;" Brad F. Chmelka from the University of California-Santa Barbara who will speak on "Ordered Inorganic-Organic Composites and Porous Solids;" and Mark Saltzman of Cornell University whose talk will be "Biomaterials that Control Cell Motility and Tissue Organization."

2001 Annual Meeting MESD Events

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:30 AM	[236] Biomaterials I <i>Sierra 1</i>	[238] Biomembranes and Biosensors #1, <i>Ruby 1</i>	[250] Plasma Processing #1, <i>Teton 1</i>	[252] Polymers for Microelectronics, <i>Teton 1</i>	[245] Preparation & Properties of Novel Ceramic & Metal-Organic Adsorbents, <i>Crystal 4</i>
	[247] Reaction Kinetics in Electronic Materials Processing, <i>Crystal 4</i>	[241] Particle Formation From Gases, <i>Silver State 2</i>	[240] Biomimetic Approaches to Materials Design, <i>Ruby 1</i>	[254] Composites Processing #1, <i>Ruby 1</i>	
	[230] Diffusion in Polymers #1, <i>Carson 2</i>	[249] Chemical Vapor Deposition, <i>Movie Theater 1</i>	[235] Polymer Processing and Rheology #3, <i>Carson 3</i>	[242] Polymer/Ceramic Composites <i>Carson 2</i>	[246] Advances in Membrane Materials, <i>Crystal 5</i>
	[111] Structure & Properties of Polymers #1 (with 1A), <i>Carson 1</i>	[118] Structure & Properties of Polymers #2 (with 1A), <i>Carson 2</i>	[128] Structure & Properties of Polymers #3 (with 1A), <i>Carson 2</i>	[135] Thermodynamics of Polymers #2 (with 1A), <i>Carson 4</i>	
	[212] Polymer Engineering Education (with 4), <i>Ruby 1</i>	[119] Polymer Thin Films & Interfaces #1 (with 1A), <i>Carson 3</i>	[129] Thermodynamics of Polymers #1 (with 1A), <i>Carson 4</i>	[43] Carriers in Gene Therapy (with T3, 15B), <i>Nevada 5</i>	[142] Modeling & Simulation of Electronic & Photonic Materials Processing (with 1A, 21, T1), <i>Cascade 1</i>
	[314] Biomimetics (with 15D), <i>Nevada 11</i>	[179] Semiconductor Surface Chemistry (with 1G), <i>Nevada 7</i>	[158] Interfacial Cellular Phenomena in Biomaterials (with 1C), <i>Nevada 9</i>		[298] Multi-Scale Modeling in Chemical & Materials Processing (with 10D), <i>Nevada 7</i>
	[339] Novel Catalytic Materials #1 (with 20), <i>Crystal 3</i>	[346] Polymerization Kinetics, Catalysis & Reaction Engineering #2 (with 20), <i>Silver State 1</i>	[318] Tissue Engineering (with 15D), <i>Nevada 11</i>		[329] Composites Based on Forest Products & Biomass Thermal Processing (with 17), <i>Crystal 2</i>
			[278] Control of Semiconductor Processes (with 10B), <i>Movie Theater 1</i>		[97] Synthesis & Processing of Nanocomposites (with 3D, T7), <i>Nevada 6</i>
2:00 PM	[237] Biomaterials #2, <i>Sierra 1</i>	[233] Polymer Processing & Rheology #2, <i>Carson 2</i>	[229] Plenary Session: Stine Award, <i>Reno Ballroom</i>	[253] Thin Film and Organic Semiconductors <i>Teton 1</i>	[102] Liquid Phase Synthesis of Nanomaterials (with 3D, T7), <i>Carson 3</i>
	[248] Transport Phenomena in Electronic Materials Processing <i>Crystal 4</i>	[239] Biomembranes & Biosensors #2 <i>Ruby 1</i>	[251] Plasma Processing # 2, <i>Teton 1</i>	[255] Composites Processing # 2, <i>Ruby 1</i>	[101] Functional Nanostructured Materials and Coatings (with 3D, T7), <i>Crystal 1</i>
	[231] Diffusion in Polymers #2, <i>Carson 2</i>	[234] Polymer Thin Films & Interfaces #2, <i>Carson 3</i>	[354] Reactor Design & Analysis for Electronic Materials (with 20), <i>Sierra 1</i>	[243] Cure & Degradation Kinetics of Network Forming Systems, <i>Carson 1</i>	
	[232] Polymer Processing & Rheology #1, <i>Carson 1</i>			[244] Ceramic Membranes <i>Crystal 5</i>	
	[343] Novel Catalytic Materials #2 (with 20), <i>Crystal 3</i>		[88] Nucleation & Crystallization of Ceramic Nano-Materials (with T7), <i>Carson 1</i>	[297] Modeling & Simulation of Materials Processing (with 10D), <i>Nevada 7</i>	
	[341] Polymerization Kinetics, Catalysis & Reaction Engineering #1 (with 20), <i>Silver State 1</i>			[94] Nanostructured Biomaterials (with 15D, T7), <i>Crystal 1</i>	
4:30 PM	[228] MESD Poster Session, <i>Hilton Pavilion</i>				

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