

# INTRODUCTION

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As has been the custom since 1992, the American Physical Society (APS), Division of Polymer Physics (DPOLY), collects together a series of contributed articles in an annual special issue. This issue is an exciting snapshot of the topics of current interest presented at the APS March Meeting. The special issue is highlighted on the Journal web page and as a result is a prominent issue with a higher than usual citation record. This year, besides the usual contributed articles, there are two special features.

Sometimes it is easy to lose sight of the bigger questions of the field. The first section of this issue is a series of short opinion pieces from well-respected researchers discussing the *big questions* or *intriguing puzzles* in Polymer Science. This series of articles represents very personal viewpoints, and hence, I am grateful to have found a group of researchers who were willing to expose their own viewpoints so freely. In fact, the enthusiasm of the contributors was surprising to me: I invited seven researchers to participate and would have been satisfied if three or four had agreed to take part. The entire group responded favorably, although, they were well aware that this was a difficult request.

The seven authors of the Viewpoints all chose very different approaches and highlighted different areas in Polymer Science. In my view, this reflects the richness of the current state of our field. Prof. A. C. Balazs presents her opinion on problems related to probing the dynamic interactions between vesicles and compliant surfaces, with a view toward controlling vesicle-substrate

interactions. She points out that advances in mesoscale modeling can contribute to the design of drugs, tissue scaffolding, and biosensors, as well as the fundamental understanding of cellular motility. In the article by Prof. S. Z. D. Cheng, he addresses the design and engineering of macromolecular structures at very small length-scales. Cheng points out that through an interdisciplinary approach, the goal of designing and building specific structures that display a particular set of macroscopic properties is possible. Prof. P.-G. de Gennes raises the glass transition as one of the essential current problems in Polymer Science. In particular, he puts forward the hope for a simple picture, which can build intuition and insight, rather than an overly complex theoretical framework. Prof. R. A. L. Jones' view is that more interaction between polymer science and biology is required. Jones encourages us to take inspiration from single molecule biophysics and biological molecular machines in the design of synthetic molecules. Prof. E. J. Kramer's article focuses on an outstanding puzzle regarding the deformation of polymer glasses: our theoretical understanding of strain hardening of polymeric glasses is insufficient, with major implications for our fundamental understanding of polymer chain geometry (*i.e.* Gaussian chains, entanglement, tube dimensions, *etc.*). Dr. A. J. Lovinger highlights "Polymer Challenges of a Different Kind" and provides a critical commentary on "bandwagon research," the importance of interdisciplinary education, and he challenges each of us to do more outreach. The physics of polyelectrolytes is the central focus of the viewpoint by Prof. M. Muthukumar. In his own words, Muthukumar points out that "polyelectrolytes are the bridge between the past successes and

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future opportunities”—a fundamental knowledge of these systems is crucial to our understanding of nature. I was particularly excited about this series of viewpoints, because my expectation is that many researchers, especially younger scientists, will find it interesting to learn what the leaders in the field are thinking. I hope that you will agree that besides being a worthwhile effort, this series of articles makes for a very enjoyable and inspiring read.

The second section of the special issue is a series of three invited articles with a focus on surface and interface behavior of polymers. Broadly defined, this is the common area for which Prof. T. P. Russell won the Polymer Prize and Prof. J. Genzer won the Dillon Medal of the DPOLY. Russell and coworkers contributed an article highlighting exciting recent results on diblock-copolymers confined to nanopores. This system provides an example of self-assembly under cylindrical geometric confinement with apparently complex and controllable morphologies. Prof. J. Genzer's

work focuses on the use of orthogonal surface-grafted polymer gradients. These samples provide a unique opportunity to do well-controlled combinatorial experiments where there is a gradient of grafting properties, for example the grafting density and molecular weight, in the two orthogonal directions. The third article is a review by Prof. U. Steiner, which focuses on capillary instabilities in thin films. Steiner demonstrates that the instability of thin, liquid films can be used as a sensitive probe of the forces that cause the instability.

The last section of the special issue is a collection of contributed articles presented at the APS March meeting in 2005. I thank all the authors for contributing to this year's special issue. This issue enables us to showcase to the extended Polymer and Soft-materials community the issues that concern us today. I especially thank the authors of the Viewpoints section for their willingness to put their own personal thoughts on paper for all of us to read.