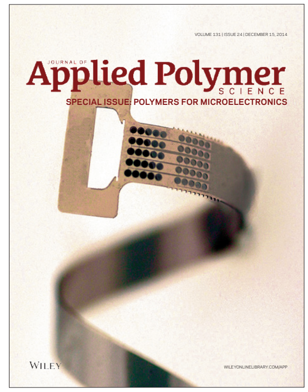
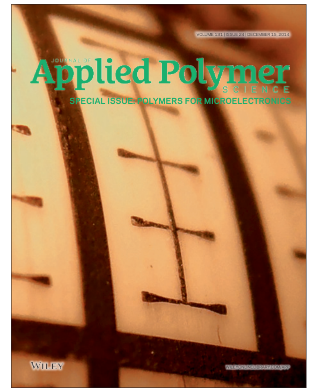
JOURNAL OF **Applied Polymer** SCIENCE

Special Issue: Polymers for Microelectronics

Guest Editors: Dr Brian Knapp (Promerus LLC) and
Prof. Paul A. Kohl (Georgia Institute of Technology)





EDITORIAL

Polymers for Microelectronics
B. Knapp and P. A. Kohl, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41233

REVIEW

Negative differential conductance materials for flexible electronics
A. Nogaret, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40169

RESEARCH ARTICLES

Generic roll-to-roll compatible method for insolubilizing and stabilizing conjugated active layers based on low energy electron irradiation
M. Helgesen, J. E. Carlé, J. Helt-Hansen, A. Miller, and F. C. Krebs, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40795

Selective etching of polylactic acid in poly(styrene)-block-poly(D,L)lactide diblock copolymer for nanoscale patterning
C. Cummins, P. Mokarian-Tabari, J. D. Holmes, and M. A. Morris, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40798

Preparation and dielectric behavior of polyvinylidene fluoride composite filled with modified graphite nanoplatelet
P. Xie, Y. Li, and J. Qiu, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40229

Design of a nanostructured electromagnetic polyaniline–Keggin iron–clay composite modified electrochemical sensor for the nanomolar detection of ascorbic acid
R. V. Lilly, S. J. Devaki, R. K. Narayanan, and N. K. Sadanandhan, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40936

Synthesis and characterization of novel phosphorous-silicone-nitrogen flame retardant and evaluation of its flame retardancy for epoxy thermosets
Z.-S. Li, J.-G. Liu, T. Song, D.-X. Shen, and S.-Y. Yang, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40412

Electrical percolation behavior and electromagnetic shielding effectiveness of polyimide nanocomposites filled with carbon nanofibers
L. Nayak, T. K. Chaki, and D. Khastgir, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40914

Morphological influence of carbon modifiers on the electromagnetic shielding of their linear low density polyethylene composites
B. S. Villacorta and A. A. Ogale, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41055

Electrical and EMI shielding characterization of multiwalled carbon nanotube/polystyrene composites
V. K. Sachdev, S. Bhattacharya, K. Patel, S. K. Sharma, N. C. Mehra, and R. P. Tandon, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40201

Anomalous water absorption by microelectronic encapsulants due to hygrothermal-induced degradation
M. van Soestbergen and A. Mavinkurve, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41192

Design of cyanate ester/azomethine/ZrO_2 nanocomposites high-k dielectric materials by single step sol-gel approach
M. Ariraman, R. Sasi Kumar and M. Alagar, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41097

Furan/imide Diels–Alder polymers as dielectric materials
R. G. Lorenzini and G. A. Sotzing, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40179

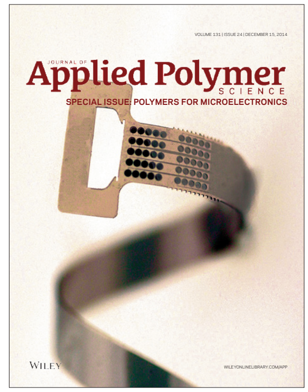
High dielectric constant polyimide derived from 5,5'-bis[(4-amino) phenoxy]-2,2'-bipyrimidine
X. Peng, Q. Wu, S. Jiang, M. Hanif, S. Chen, and H. Hou, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40828

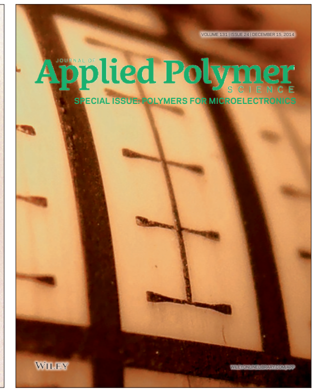
The influence of rigid and flexible monomers on the physical-chemical properties of polyimides
T. F. da Conceição and M. I. Felisberti, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40351

Journal of Applied Polymer Science

Special Issue: Polymers for Microelectronics

Guest Editors: Dr Brian Knapp (Promerus LLC) and
Prof. Paul A. Kohl (Georgia Institute of Technology)





Development of polynorbornene as a structural material for microfluidics and flexible BioMEMS
A. E. Hess-Dunning, R. L. Smith, and C. A. Zorman, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40969

A thin film encapsulation layer fabricated via initiated chemical vapor deposition and atomic layer deposition
B. J. Kim, D. H. Kim, S. Y. Kang, S. D. Ahn, and S. G. Im, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40974

Surface relief gratings induced by pulsed laser irradiation in low glass-transition temperature azopolysiloxanes
V. Damian, E. Resmerita, I. Stoica, C. Ibanescu, L. Sacarescu, L. Rocha, and N. Hurduc, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41015

Polymer-based route to ferroelectric lead strontium titanate thin films
M. Benkler, J. Hobmaier, U. Gleißner, A. Medesi, D. Hertkorn, and T. Hanemann, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40901

The influence of dispersants that contain polyethylene oxide groups on the electrical resistivity of silver paste
T. H. Chiang, Y.-F. Chen, Y. C. Lin, and E. Y. Chen, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41183

Quantitative investigation of the adhesion strength between an SU-8 photoresist and a metal substrate by scratch tests
X. Zhang, L. Du, and M. Zhao, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.41108

Thermodynamic and kinetic aspects of defectivity in directed self-assembly of cylinder-forming diblock copolymers in laterally confining thin channels
B. Kim, N. Laachi, K. T. Delaney, M. Carilli, E. J. Kramer, and G. H. Fredrickson, *J. Appl. Polym. Sci.* 2014, **DOI:** 10.1002/app.40790

Journal of Applied Polymer Science

EDITORIAL

Polymers for Microelectronics

Welcome to this special issue of the *Journal of Applied Polymer Science* focused on innovations in polymer science and engineering in microelectronic devices and packaging. The electronics industry is one of the largest industries in the world currently valued at $1.7 Tr/year. A wide range of chemicals and materials are used in the fabrication of electronic components and systems. Polymeric materials play an especially important role—according to Prismark Partners LLC, $48 Bn worth were used in 2013 (private communication).

Electronic devices have transformed virtually every aspect of our lives and will continue to dazzle us with new and better functionality for years to come. The heart of the electronics industry is the fabrication and packaging of miniature entities, such as integrated circuits (ICs) and microelectromechanical devices. A critical aspect of the improvement in cost and performance of these is that their capability and capacity scale with decreasing size of transistors. That is, the density and performance of an IC improves when the transistors are scaled to smaller dimensions. The remarkable historical track record of advancement could not have occurred without significant contributions from the field of polymer science and engineering. Polymers are the dominant material used in microfabrication for (i) pattern transfer and (ii) specific areas of insulation. Polymer technology has been used from the fabrication of the first IC for pattern transfer. Early photoresists based on bis-arylazide rubber were borrowed from other industries, and were used to create photopatterned films on silicon wafers as a masking layer for etching and depositing materials. Alongside this, the packaging world recognized early-on the versatility and high-value of bisphenol A diglycidyl ether for forming permanent dielectrics and structural materials, such as printed circuit boards.

Many generations of advances in the use of polymers in microelectronics have occurred since the beginning of the electronic revolution in the 1960s. In addition to modeling and measurement, this special issue attempts to capture a wide array of up-to-date applications and techniques. Polymer-based patterning has continued to progress—current topics include stamping, photolithography, nanoimprinting, electron-beam lithography, and self-assembly. The goal is to stretch the limits of patterning technology from micrometer to nanometer dimensions, including meeting the present requirement of patterning at a 10 nm minimum feature size. Researchers are persistently modifying chemistries to promote aqueous-based developing technologies, and adapting techniques (e.g., additive processing via printable electronics) to afford a more environmentally friendly industry.

Specifically, we lead with a review article by Nogaret describing the complexities associated with transferring IC's to a flexible, three-dimensional world. From there, we dive into the familiar, yet ever-changing arena of composites represented by applications for electrical energy storage, epoxy molding compounds and flame retardancy, environmental protection of electronic packages, and materials for electromagnetic shielding. Other applications described are microfluidics for bioMEMS, photovoltaics, reliability of organic electronics, and fabrication of sensors. The polymer systems used for these are polyimides, polybenzoxazoles, siloxanes, parylene and polycyclic olefins. Overall, work is aimed at tailoring the mechanical properties, dielectric properties, thermal stability, and cure temperature, as well as mitigating packaging stress coupled with improving interfacial adhesion.

We would like to thank the authors and peer-reviewers who have made the publication of these manuscripts possible. We would also like to thank Hilary Crichton, as the Associate Editor of this issue, as well as Stefano Tonzani, our Editor-in-Chief, who along with Hilary conceptualized this series of special issues. It is clear that the electronics industry could not have occurred and cannot move forward at the same pace without creative advances in polymer science and engineering. Beyond this issue, we hope to bring you much of this progress in the pages of future volumes of the *Journal of Applied Polymer Science.*

Brian Knapp
Executive Editor
Journal of Applied Polymer Science
Promerus LLC
Brecksville, U.S.A.

Paul A. Kohl
School of Chemical and Biomolecular Engineering
Georgia Institute of Technology
Atlanta, U.S.A.