Chris E. Scott, Ph.D.
President

Material Answers LLC
Tel. 617-378-1976
cscott@materialanswers.com

Professional Profile

Dr. Chris E. Scott is President of Material Answers LLC. He specializes in material structure, properties, and processing. His work emphasizes thermoplastics, thermosets, blends, composites, and multicomponent formulations. He has extensive experience with manufacturing, product development, product design, and failure analysis. Systems investigated include plastics, coatings, paints, adhesives, rubbers, fibers, suspensions, emulsions, and pastes. In particular, Dr. Scott has published extensively on the topics of polymer processing and structure relationships, compounding and mixing in multiphase polymer systems, and structure and morphology development during polymer processing. He is the inventor on 10 U.S. patents, author of more than 30 articles in refereed journals, author of 40 conference proceedings, and has presented more than 50 seminars to industry and government organizations.

Dr. Scott has conducted failure analysis investigations and developed product designs in a broad range of applications, including: automotive components, consumer products, medical devices, aerospace, pharmaceuticals, coatings, prints, construction materials, and packaging. Numerous material systems have been assessed relative to long term stability, aging, degradation, and chemistry. Collaborative projects have encompassed evaluation of environmental and human health issues in addition to classical accident and defect analysis.

Prior to founding Material Answers LLC, Dr. Scott has had both industrial and academic experience:

Material Answers LLC, 2004 – present.
President and Founder
Bezin LLC, 2012 – present.
President and Co-Founder
Fusion Optix Inc., 2004 – 2006.
Manager, Material Science
Exponent Failure Analysis Associates, 2001 – 2004.
Managing Engineer
Massachusetts Institute of Technology, 2000 – 2001.
Associate Professor, Department of Material Science and Engineering
Massachusetts Institute of Technology, 1994 – 2000.
Assistant Professor, Department of Material Science and Engineering
Eastman Chemical Company, 1990 – 1994.
Senior Engineer

Credentials and Professional Honors

Ph.D., Chemical Engineering, University of Minnesota, 1990
M.S., Macromolecular Science, Case Western Reserve University, 1986
B.S., Chemical Engineering, Case Western Reserve University, 1985

Polymer Processing Society Morand Lambla Award;
3M Faculty Award;
DuPont Young Professor Award;
National Science Foundation CAREER Award;
University of Minnesota Doctoral Dissertation Fellowship;
Plastics Institute of America Scholarship;
National Science Foundation Graduate Fellowship;
DuPont-Conoco Fellowship in Chemical Engineering;
Philip Bliss Prize for Scholarly Excellence;
A.W. Smith Prize;
Ernest B. Yeager Award for Undergraduate Research;
AIChE Outstanding Academic Student Award;
Smith/Horsburgh/Treuhaft Scholarship.

Society of Plastics Engineers – member.
Polymer Processing Society – member.
American Institute of Chemical Engineers – member.

Patents

"Methods for Generating Interfacial Surfaces and Devices Therefor," United States Patent 11,577,440, issued 14 Feb 2023 (with S.A. Winroth).

"Polybenzoxazine Resins with High Hydrogen Content, and Composites Therefrom," United States Patent 11,124,608, issued 21 Sep 2021 (with H. Ishida and S.A. Winroth).

"Blends of Polyetherimides with Polyesters of 2,6-Naphthalenedicarboxylic Acid," United States Patent 6,252,011, issued 2001.

"Clear Polycarbonate and Polyester Blends," United States Patent 6,043,322, issued 2000 (with J.C. Morris and J.R. Bradley).

"Clear Blends of Polycarbonates and Polyesters," United States Patent 6,037,424, issued 2000 (with J.C. Morris and J. R. Bradley).

"Clear Polycarbonate and Polyester Blends," United States Patent 6,005,059, issued 2000 (with J.C. Morris and J.R. Bradley).

"Polycarbonate and Polyester Blends," United States Patent 5,942,585, issued 1999 (with M.E. Stewart, D.S. Wilmoth, J.C. Morris, and J.R. Bradley).

"Ternary Polyetherimide/Polyester/Polyether Blends," United States Patent 5,648,433, issued 1997.

"Blends of Polyarylates with Aliphatic Polyesters," United States Patent 5,502,121, issued 1996 (with J.D. Small, H. Yang, P.D. Yacobucci, and G.M. Stack).

"Blends of Certain Polyesters with Acrylics," United States Patent 5,498,668, issued 1996.

"High Heat Deflection Temperature Blends of Certain Polyesters with Polyetherimides," United States Patent 5,439,987, issued 1995 (with M.F. Meyer, K.E. Breeding, and J.T. Owens).

Publications

"Development of an Atomic-Oxygen-Erosion-Resistant, Alumina-Fiber-Reinforced, Fluorinated Polybenzoxazine Composite for Low-Earth Orbital Applications," *Polymers*, **2023**, *15*(1) p. 112 (with L. Oppenheimer, M. Ramkumar, I. Machado, S. Winroth, and H. Ishida).

"Special Issue in Honor of Professor Christopher W. Macosko," *Polym. Engr. Sci.*, 2021; **61**:923-925 (with U. Sundararaj).

"Structure and Performance of Benzoxazine Composites for Space Radiation Shielding," *Molecules*, **2020**, *25*, 4346 (with S. Winroth and H. Ishida).

"Development of Hydrogen-Rich Benzoxazine Resins with Low Polymerization Temperature for Space Radiation Shielding," *ACS Omega*, Vol. 3, p. 11569-11581, 2018 (with D. Iguchi, S. Ohashi, G.J.E. Abarro, X. Yin, S. Winroth, M. Gleydura, L. Jin, N. Kanagasegar, C. Lo, C.R. Arza, P. Froimowicz, and H. Ishida).

"Copolymers Based on Telechelic Benzoxazine with a Reactive Main-chain and Anhydride: Monomer and Polymer Synthesis, and Thermal and Mechanical Properties of Carbon Fiber Composites," RSC Advances, Vol. 5, p. 16785, 2015 (with J. Liu, S. Winroth, J. Maia, H. Ishida).

"On Modes and Criteria of ABS Melt Failure in Extension," *Rheol. Acta*., Vol. 41, p. 567, 2002 (with J.K. Lee, T.L. Virkler).

"Blade Geometry Effects on Chopped Glass Fiber Dispersion," *Polym. Composites*, Vol. 23, p. 828, 2002 (with M. Kuroda).

"Effects of ABS Rubber Particles on Rheology, Melt Failure, and Thermoforming," *Polym. Engr. Sci*., Vol. 42, p. 1541, 2002 (with J.K. Lee, T.L. Virkler).

"Effect of Addition Protocol on Mixing in Miscible and Immiscible Polymer Blends," *Polym. Engr. Sci.*, Vol. 42, p. 1197, 2002 (with H.E. Burch).

"Initial Dispersion Mechanisms of Chopped Glass Fibers in Polystyrene," *Polym. Composites*, Vol. 23, p. 395, 2002 (with M. Kuroda).

"Miscible poly(benzoyl paraphenylene) – Polycarbonate Blends for Improved Processing," *Polymer*, Vol. 42, p. 6463, 2001 (with T.-H. Ha, E.L. Thomas).

"Influence of Initial Sheet Temperature on ABS Thermoforming," *Polym. Engr. Sci*., Vol. 41, p. 1830, 2001 (with J.K. Lee, T.L. Virkler).

"Visualization and Microscopic Modeling of Phase Inversion During Compounding," *Polym. Engr. Sci*., Vol. 41, p. 1310, 2001 (with R. Ratnagiri).

"Evolution of Structure in the Softening/Melting Regime of Miscible Polymer Mixing," *Polym Engr. Sci*., Vol. 41, p. 1038, 2001 (with H.E. Burch).

"The Effect of Scaleup on the Processing Behavior of a Blend Exhibiting Phase Inversion During Compounding," *Polym. Engr. Sci*., Vol. 41, p. 1019, 2001 (with R. Ratnagiri and C.K. Shih).

"Effect of Viscosity Ratio on Structure Evolution in Miscible Polymer Blends," *Polymer*, Vol. 42, p. 7313, 2001 (with H.E. Burch).

"Morphology Development During Phase Inversion in Isothermal, Model Experiments: Steady Simple Shear and Quiescent Flow Fields," *Polymer*, Vol. 42, p. 4219, 2001 (with N.D.B. Lazo).

"Effects of Rheological Properties and Processing Parameters on ABS Thermoforming," *Polym. Engr. Sci*., Vol. 41, p. 240, 2001 (with J.K. Lee, T.L. Virkler).

"Simulations of a Cusped Bubble Rising in a Viscoelastic Fluid with a New Numerical Method," *J. Comp. Phys. Comm.*, Vol. 129, p. 227, 2000 (with A. Wagner and L. Giraud).

"Initial Mechanisms of Dispersion of Core Shell Impact Modifiers in a Polymer Matrix," *J. Vinyl Additive Tech.*, Vol.5, p. 125, 1999 (with L.D. Rockford).

"Rheology of ABS Polymer Melts and Viscoelastic Constitutive Models," *J. Rheol*, Vol. 43, p. 977, 1999 (with S. Solovyov and T.L. Virkler).

"Morphology Development During Phase Inversion of a PS/PE Blend in Isothermal, Steady Shear Flow," *Polymer*, Vol. 40, p. 5469, 1999 (with N. Lazo).

"Effect of Viscosity Variation with Temperature on the Compounding Behavior of Immiscible Blends," *Polym. Engr. Sci*., Vol. 39, p. 1823, 1999 (with R. Ratnagiri).

"Phase Inversion During Compounding with a Low Melting Major Component: Polycaprolactone/Polyethylene Blend," *Polym. Engr. Sci.*, Vol. 38, p. 1751, 1998 (with R. Ratnagiri).

"Viscosity Ratio Effects in the Compounding of Low Viscosity, Immiscible Fluids into Polymeric Matrices," *Polym. Engr. Sci.*, Vol. 36, p. 1666, 1996 (with S.K. Joung).
"Processing and Morphology of Polystyrene/Ethylene-Propylene Rubber Reactive and Nonreactive Blends," *Polym. Engr. Sci*., Vol. 35, p. 1938, 1995 (with C.W. Macosko).

"Compounding and Morphology of Nylon/Ethylene-Propylene Rubber Reactive and Nonreactive Blends," *Int. Polym. Processing*, Vol. 10, p. 36, 1995 (with C.W. Macosko).

"Morphology Development During the Initial Stages of Polymer-Polymer Blending," *Polymer*, Vol. 36, p. 461, 1995 (with C.W. Macosko).

"Morphology Development During Reactive and Nonreactive Blending of an Ethylene-Propylene Rubber with Two Thermoplastic Matrices," *Polymer*, Vol. 35, p. 5422, 1994 (with C.W. Macosko).

"Model Experiments for the Interfacial Reaction Between Polymers During Reactive Polymer Blending," *J. Polym. Sci., Polym. Physics*, Vol. 32, p. 205, 1994 (with C.W. Macosko)

"Morphology Development in Polymer Blends," *Seikei Kakou*, Vol. 5, p. 571, 1993 (with C.W. Macosko and U. Sundararaj).

"The Recirculating Screw Mixer: A New Small-Volume Intensive Mixer for the Polymer Laboratory," *Polym. Engr. Sci.,* Vol. 33, p. 1065, 1993 (with C.W. Macosko).

"Rubber-Filler Interaction Effects on the Solid State Dynamic Mechanical Properties of Polyethylene/EPDM/Calcium Carbonate Composites," *Polym. Composites*, Vol. 13, p. 237, 1992 (with H. Ishida and F.H.J. Maurer).

"Model Experiments Concerning Morphology Development During the Initial Stages of Polymer Blending," *Polymer Bulletin*, Vol. 26, p. 341, 1991 (with C.W. Macosko).

"Characterization of Polyethylene/EPDM/Silicon Dioxide Multicomponent Composites by Solid State Dynamic Mechanical Spectroscopy," *J. Mater. Sci.*, Vol. 26, p. 5708, 1991 (with H. Ishida and F.H.J. Maurer).

"Melt State Dynamic Mechanical Properties of Polyethylene/EPDM/Silicon Dioxide Composites," *J. Reinf. Plast. Comp.*, Vol. 10, p. 463, 1991 (with H. Ishida and F.H.J. Maurer).

"Interfacial Effects on the Melt State Behavior of Polyethylene/EPDM/Calcium Carbonate Composites," *Rheol. Acta.*, Vol. 27, p. 273, 1988 (with H. Ishida and F.H.J. Maurer).

"Infrared Analysis and Izod Impact Testing of Multicomponent Polymer Composites: Polyethylene/EPDM/Filler Systems," *J. Mater. Sci.*, Vol. 22, p. 3963, 1987 (with H. Ishida and F.H.J. Maurer).

"Fast Polymerization and Crystallization Studies of Nylon 6 by Combined use of Micro-RIM Machine and FT-IR," *J. Polym. Engr.*, Vol. 6, p. 201, 1986 (with H. Ishida).

Conference Proceedings

"Development of Multifunctional Composites for Space Radiation Shielding Applications," SPE ANTEC, Detroit, MI, 2019 (with S. Winroth and H. Ishida).

"Future Evolution of Polymer Products and Manufacturing Processes – A Perspective Based on Current Trends," SPE ANTEC, paper #1302, 2003 (with M.T. BenKinney and K.T. Connor).

"Morphology Development in Multicomponent Polymer Systems," Polymer Processing Society 18th Annual Meeting, Guimaraes, Portugal, June 16-20, 2002.

"Study of Rheological Properties and Processing Parameters for ABS Thermoforming," Polymer Processing Society, 16th Annual Meeting, Shanghai, June 19–22, 2000 (with J.K. Lee and T.L. Virkler).

"Non-Uniqueness of Late-Time Scaling States in Spinodal Decomposition," Polymer Processing Society, 16th Annual Meeting, Shanghai, June 19–22, 2000 (with A.J. Wagner).

"A Morphological Model for Phase Inversion During Compounding in Batch Intensive Mixers," Polymer Processing Society, 16th Annual Meeting, Shanghai, June 19–22, 2000 (with R. Ratnagiri).

"Wall-Liquid Heat Transfer Coefficients in Batch Intensive Mixers," *SPE ANTEC*, Vol. 46, p. 418, 2000 (with M. Deopura).

"Investigation of the Mechanisms by Which Glass Fibers Disperse in a Polystyrene Matrix," *SPE ANTEC*, Vol. 46, p. 2231, 2000 (with M.H. Kuroda).

"The Effect of Feed Particle Size on the Characteristic Size Scales for a Miscible SAN/PMMA Blend," *SPE ANTEC*, Vol. 46, p. 2463, 2000 (with H.E. Burch).

"Isolating the Effect of Reaction on the Phase Inversion of Model PA/PS Blends," *SPE ANTEC*, Vol. 46, p. 2500, 2000 (with N.D.B. Lazo).

"Investigation of the Phase Behavior of Blends of Poly(Benzoyl Paraphenylene) and Various Thermoplastics," *SPE ANTEC*, Vol. 46, p. 2532, 2000 (with Y.H. Ha and E.L. Thomas).

"The Effect of Scaleup on the Processing Behavior of a Blend Exhibiting Phase Inversion During Compounding," NSF Design and Manufacturing Conf., Vancouver, January 2000, (with R. Ratnagiri).

"Effect of Scale and Blade Configuration on the Compounding of Polymer Blends with a Low-Viscosity Minor Component in Batch Mixers," Polymer Processing Society, 15th Annual Meeting, Netherlands, May 31–June 4 1999 (with R. Ratnagiri).

"Lattice-Boltzmann Simulations of Viscoelastic Binary Mixtures," Polymer Processing Society, 15th Annual Meeting, Netherlands, May 31–June 4 1999 (with A.J. Wagner).
"A Quantitative Investigation of Mixing in a Miscible SAN/PMMA Blend," *SPE ANTEC*, Vol. 45, p. 152, 1999 (with H.E. Burch).

"The Effect of Scale-Up on the Processing Behavior of a Blend Exhibiting Phase Inversion During Compounding," *SPE ANTEC*, Vol. 45, p. 177, 1999 (with R. Ratnagiri and C.K. Shih).

"Lattice-Boltzmann Simulations as a Tool to Examine Multiphase Flow Problems for Polymer Processing Applications," *SPE ANTEC*, Vol. 45, p. 240, 1999 (with A. Wagner).

"Numerical Modelling of the Phase Inversion Process," NSF Design and Manufacturing Conf., San Francisco, January 1999 (with R. Ratnagiri).

"Lattice-Boltzmann Simulation of Multiphase Flow," *Compounding '98*, Boston, 1998.

"Rheological Aspects of ABS Thermoforming," Polymer Processing Society, 14th Annual Meeting, Yokohama, Japan, June 8, 1998 (with S.E. Solovyov and T.L. Virkler).

"Lattice-Boltzmann Simulation of Multiphase Flow in Polymer Processing," Polymer Processing Society, 14th Annual Meeting, Yokohama, Japan, June 8, 1998 (with A. Suwa).

"Simulation of Phase Domain Breakup and Coalescence Using the Lattice-Boltzmann Method," *SPE ANTEC*, Vol. 44, p. 232, 1998 (with A. Suwa).

"Optimization of Processing Conditions in Thermoforming," *SPE ANTEC*, Vol. 44, p. 696, 1998 (with C.M. Bordonaro, T.L. Virkler, P.A. Galante, and B. Pineo).

"Rheology and Constitutive Equations for ABS Polymer Melts," *SPE ANTEC*, Vol. 44, p. 2128, 1998 (with S.E. Solovyov and T.L. Virkler).

"Investigation of Mixing During Melting in Polymer Compounding," NSF Design and Manufacturing Conf., Monterrey, Mexico, Jan. 5–8, 1998 (with R. Ratnagiri).

"Phase Inversion During Compounding—The Effect of Viscosity Variation with Temperature," *SPE ANTEC*, Vol. 43, p. 170, 1997 (with R. Ratnagiri).

"Cellular Automata Simulation of Droplet Breakup and Coalescence in Polymer Blending," Polymer Processing Society, 13th Annual Meeting, Secaucus, NJ, June 10, 1997 (with A. Suwa).

"Recent Advances in Understanding Phase Inversion During Compounding of Immiscible Polymer Blends," Polymer Processing Society 13th Annual Meeting, Secaucus, NJ, June 10, 1997.

"Effects of Relative Transition Temperature and Viscosity Ratio in Compounding of Immiscible Polymers," *AIChE Annual Meeting*, Chicago, IL, p. 78, 1996.

"Dissipative Mix-Melting in Immiscible Polymer Blends," *Compounding 96*, Philadelphia, 1996.

"Phase Inversion During Compounding of Polycaprolactone/Polyethylene Blends," *SPE ANTEC*, Vol. 42, p. 59, 1996 (with R. Ratnagiri).

"Viscosity Ratio Effects in the Compounding of Low Viscosity, Immiscible Fluids into Polymer Matrices," *Polyblends '95*, Montreal, October 1995 (with S.K. Joung).

"Compounding of Core-Shell Impact Modifiers into Polymer Matrices: Initial Mechanisms of Dispersion," Poly. Processing Soc. Meeting, Akron, November 1995 (with L.D. Rockford).

"Rheology of Reactive Polystyrene/Ethylene-Propylene Rubber Blends," *SPE ANTEC*, Vol. 41, p. 1135, 1995 (with C.W. Macosko).

"Advances in the Understanding of Morphology Development During Polymer Blending," 2nd Int. Conf. on Additives and Modifiers for Polymer Blends, Philadelphia, February 1993 (with C.W. Macosko).

"The Recirculating Screw Mixer," Polym. Processing Soc., 7th Annual Meeting, Hamilton, Ontario, 1991 (with C.W. Macosko).

"Viscosity Changes and Morphology Development During the Reactive and Non-Reactive Blending of an Amorphous Nylon with Ethylene-Propylene Rubber," Polym. Processing Soc. Meeting, Nice, April 1990 (with C.W. Macosko).

"Morphology Development During Reactive and Non-Reactive Polymer Blending," 6th International Conf. on Reactive Processing of Polymers, Montreal, July 1990 (with C.W. Macosko).

"Processing, Morphology, and Rheology of Polystyrene/Ethylene-Propylene Rubber Reactive and Non-Reactive Blends," AIChE Annual Meeting, San Francisco, November 1989 (with C.W. Macosko).

"Characterization of Reactive Blending Kinetics," *Polym. Prep. (Am. Chem. Soc., Div. Polym. Chem.)*, Vol. 29, p. 561, 1988 (with C.W. Macosko).

"Fast Molecular Kinetic Study of RIM Reactions by FT-IR: Simultaneous Urethane Formation and Vinyl Polymerization," Polymer Proc. Soc. Meeting, Montreal, April 1986 (with H. Ishida).

Book Chapter

"Morphological and Rheological Aspects of Reactive Blending," in **Reactive Polymer Blending**, Eds. W.E. Baker, C.E. Scott, G.-H. Hu, Carl Hanser, 2001 (with N.D.B. Lazo).