Kenneth R. Shull

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RESEARCH INTERESTS:

Surface and interfacial structure of polymeric materials; polymer adhesion and the mechanics of soft materials; nanoparticle dispersions in polymer matrices.

EXPERIENCE:

2003-	Northwestern University, Evanston, IL Professor, Dept. of Materials Science and Engineering
1999-2003	Northwestern University, Evanston, IL Associate Professor, Dept. of Materials Science and Engineering
Sep.-Nov., 2000:	Visiting Scientist, Laboratoire de Physicochimie Structurale et Macromoléculaire, Ecole Supérieure de Physique et de Chimie Industrielles (ESPCI, Paris)
Dec., 2000	Visiting Scientist, Department of Physics, University of Sheffield (UK)
1993-1999	Northwestern University, Evanston, IL Assistant Professor, Dept. of Materials Science and Engineering
1990-1993	IBM Almaden Research Center, San Jose, CA Research Staff Member

EDUCATION:

1990	Ph.D. - Dept. of Materials Science and Engineering, Cornell University Thesis title: "Diffusion and Interface Segregation in Model Polymer Systems"
1985	M.S. in Electronic Materials - Dept. of Materials Science and Engineering, MIT Thesis title: "Magnetic Thin Film Multilayers"
1984	B.S. in Materials Science - Dept. of Materials Science and Engineering, MIT

HONORS:

2002	Fellow, American Physical Society
1998	McCormick Advisor of the Year Award
1995	Mat. Sci. and Eng. Teacher of the Year Award
1994	NSF Young Investigator Award
1993-1996	Morris Fine Junior Professorship, Northwestern University
1986-1989	AT&T Ph.D. Scholar

REFEREED JOURNAL ARTICLES: 92

Refereed Journal Articles

1. "Diffusion of Macromolecular Stars in Linear, Microgel and Network Matrices" K.R. Shull; E.J. Kramer; G. Hadziioannou; M. Antonietti; H. Sillescu, *Macromolecules*, **21**, 2578 (1988).
2. "Effect of Number of Arms on Diffusion of Star Polymers" K.R. Shull; E.J. Kramer; L.J. Fetters, *Nature*, **345**, 790 (1990).
3. "Mean-Field Theory of Polymer Interfaces in the Presence of Block Copolymers" K.R. Shull; E.J. Kramer, *Macromolecules*, **23**, 4769 (1990).
4. "Segregation of Block Copolymers to Interfaces between Immiscible Homopolymers" K.R. Shull; E.J. Kramer; G. Hadziioannou; W. Tang, *Macromolecules*, **23**, 4780 (1990).
5. "Diffusion by Constraint Release in Branched Macromolecular Matrices" K.R. Shull; K.H. Dai; E.J. Kramer; L.J. Fetters; M. Antonietti; H. Sillescu, *Macromolecules*, **24**, 505 (1991).
6. "Segregation of Block Copolymer Micelles to Surfaces and Interfaces" K.R. Shull; K.I. Winey; E.L. Thomas; E.J. Kramer, *Macromolecules*, **24**, 2748 (1991).
7. "Self-Diffusion of Symmetric Diblock Copolymer Melts Near the Ordering Transition" K.R. Shull; E.J. Kramer; F.S. Bates; J.H. Rosedale, *Macromolecules*, **24**, 1383 (1991).
8. "Theory of End-Adsorbed Polymer Brushes in Polymeric Matrices" K.R. Shull, *J. Chem. Phys.*, **94**, 5723 (1991).
9. "Mean-Field Theory of Block Copolymers: Bulk Melts, Surfaces and Thin Films" K.R. Shull, *Macromolecules*, **25**, 2122 (1992).
10. "Neutron scattering by mulitblock copolymers of structure $(A\text{-}B)_nA$" G. Hadziioannou; H. Benoit; W. Tang; K. Shull; C.C. Han, *Polymer*, **33**, 4677 (1992).
11. "Interfacial Segregation in Two-Phase Polymer Blends with Diblock Copolymer Additives: The Effect of Homopolymer Molecular Weight" K.H. Dai; E.J. Kramer; K.R. Shull, *Macromolecules*, **25**, 220 (1992).
12. "Morphologies of Discontinuous Gold Films on Amorphous Polymer Substrates" M.S. Kunz; K.R. Shull; A.J. Kellock, *J. Appl. Phys.*, **72**, 4458 (1992).
13. "Homopolymer Distributions in Lamellar Copolymer/Homopolymer Blends" K.R. Shull; K.I. Winey, *Macromolecules*, **25**, 2637 (1992).
14. "Interfacial Segment Density Profiles of End-Anchored Polymers in a Melt" R.A.L. Jones; L.J. Norton; K.R. Shull; E.J. Kramer; G.P. Felcher; A. Karim; L.J. Fetters, *Macromolecules*, **25**, 2359 (1992).
15. "Vanishing Interfacial Tension in an Immiscible Polymer Blend" K.R. Shull; A.J. Kellock; V.R. Deline; S.A. MacDonald, *J. Chem. Phys.*, **97**, 2095 (1992).
16. "Segment Distributions in Lamellar Diblock Copolymers" K.R. Shull; A.M. Mayes; T.P. Russell, *Macromolecules*, **26**, 3929 (1993).
17. "Interfacial Phase Transitions in Block Copolymer/Homopolymer Blends" K.R. Shull, *Macromolecules*, **26**, 2346 (1993).
18. "Colloidal Gold Dispersions in Polymeric Matrices" M.S. Kunz; K.R. Shull; A.J. Kellock, *J. Coll. Int. Sci.*, **156**, 240 (1993).
19. "Improved Technique for Cross Sectional Imaging of Thin Polymer Films by Transmission Electron Microscopy" M. Kunz; K. Shull, *Polymer*, **34**, 2427 (1993).

20. "Topological Coarsening of Symmetric Diblock Copolymer Films: Model 2-D Systems" P. Bassereau; D. Brodbreck; T.P. Russell; H.R. Brown; K.R. Shull, *Phys. Rev. Lett.*, **71**, 1716 (1993).

21. "Molecular Weight Effects in Chain Pullout" C. Creton; H.R. Brown; K.R. Shull, *Macromolecules*, **27**, 3174 (1994).

22. "Dewetting Dynamics for Large Equilibrium Contact Angles" K.R. Shull; T.E. Karis, *Langmuir*, **10**, 334 (1994).

23. "Wetting Autophobicity of Polymer Melts" K.R. Shull, *Faraday Discussions*, **98**, 203 (1994).

24. "The structure of Grafted Polystyrene Layers in a Range of Matrix Polymers" C.J. Clarke; R.A.L. Jones; J.L. Edwards; K.R. Shull; J. Penfold, *Macromolecules*, **28**, 2042 (1995).

25. "Equilibrium Contact Angle for Polymer/Polymer Interfaces" E. Vitt; K.R. Shull, *Macromolecules*, **28**, 6349 (1995).

26. "Metal Particle Adsorption and Diffusion in a Model Polymer/Metal Composite System" K.R. Shull; A.J. Kellock, *J. Poly. Sci., Polym. Phys.*, **33**, 1417 (1995).

27. "End-Adsorbed Polymer Brushes in High- and Low-Molecular Weight Matrices" K.R. Shull, *Macromolecules*, **29**, 2659 (1996).

28. "JKR studies of Acrylic Elastomer Adhesion" D. Ahn; K.R. Shull, *Macromolecules*, **29**, 4381 (1996).

29. "Wetting Behavior of Polymer Melts on Polydisperse Grafted Polymer Layers" K.R. Shull, *Macromolecules*, **29**, 8487 (1996).

30. "Adhesion of Thermally Reversible Gels to Solid Surfaces" C.L. Mowery; A.J. Crosby; D. Ahn; K.R. Shull, *Langmuir*, **13**, 6101 (1997).

31. "Finite-Size Corrections to the JKR Technique for Measuring Adhesion: Soft Spherical Caps Adhering to Flat, Rigid Surfaces" K.R. Shull; D. Ahn; C. Mowery, *Langmuir*, **13**, 1799 (1997).

32. "Axisymmetric Adhesion Tests of Pressure Sensitive Adhesives" K.R. Shull; A. Crosby, *J. Eng. Mater. Tech.*, **119**, 211 (1997).

33. "Metal-Polymer Interactions in a Polymer/Metal Nanocomposite" D.H. Cole; K.R. Shull; L.E. Rehn; P. Baldo, *Phys. Rev. Lett.*, **78**, 5006 (1997).

34. "RBS analysis of the diffusion of nano-size spheres in a polymer matrix" D.H. Cole; K.R. Shull; L.E. Rehn; B. Baldo, *Nucl. Inst. and Meth. B.*, **138**, 283 (1998).

35. "Effects of Methylation and Neutralization of Carboxylated Poly(n-butyl acrylate) on the Interfacial and Bulk Contributions to Adhesion" D. Ahn; K.R. Shull, *Langmuir*, **14**, 3637 (1998).

36. "Effects of Substrate Modification on the Interfacial Adhesion of Acrylic Elastomers as Measured by the JKR Technique" D. Ahn; K.R. Shull, *Langmuir*, **14**, 3646 (1998).

37. "Axisymmetric Adhesion Tests of Soft Materials" K.R. Shull; D. Ahn; W.-L. Chen; C.M. Flanigan; A.J. Crosby, *Macromol. Chem. and Phys.*, **199**, 489 (1998).

38. "Dynamic Properties of a Model Polymer/Metal Nanocomposite: Gold Particles in Poly(t-butyl acrylate)" D.H. Cole; K.R. Shull; L. Rehn; P. Baldo, *Macromolecules*, **32**, 771 (1999).

39. "Equilibrium Swelling of Hydrophilic Polyacrylates in Humid Environments" W.-L. Chen; K.R. Shull; T. Papatheodorou; D.A. Styrkas; J.L. Keddie, *Macromolecules*, **32**, 136 (1999).

40. "Adhesive Failure Analysis of Pressure-Sensitive Adhesives" A.J. Crosby; K.R. Shull, *J. Polym. Sci., Polym. Phys.*, **37**, 3455 (1999).
41. "Hydrophilic Surface Coatings from Acrylic Block Copolymers" W.-L. Chen; K.R. Shull, *Macromolecules*, **32**, 6298 (1999).
42. "Adhesive and Elastic Properties of Thin Gel Layers" C.M. Flanigan; K.R. Shull, *Langmuir*, **15**, 4966 (1999).
43. "Fracture mechanics studies of adhesion in biological systems" K.R. Shull; W.L. Chen, *Interface Sci.*, **8**, 95 (2000).
44. "Structural Development and Adhesion of Acrylic ABA Triblock Copolymer Gels" C.M. Flanigan; A.J. Crosby; K.R. Shull, *Macromolecules*, **32**, 7251 (1999).
45. "Study of the Surface Adhesion of Pressure-Sensitive Adhesives by Atomic Force Microscopy and Spherical Indenter Tests" A. Paiva; N. Sheller; M.D. Foster; A.J. Crosby; K.R. Shull, *Macromolecules*, **33**, 1878 (2000).
46. "Fingering Instabilities of Confined Elastic Layers in Tension" K.R. Shull; C.M. Flanigan; A.J. Crosby, *Phys. Rev. Lett.*, **84**, 3057 (2000).
47. "Deformation and Failure Modes of Adhesively Bonded Elastic Layers" A.J. Crosby; K.R. Shull; H. Lakrout; C. Creton, *J. Appl. Phys.*, **88**, 2956 (2000).
48. "Rheological Properties and Adhesive Failure of Thin Viscoelastic Layers" A.J. Crosby; K.R. Shull; Y.Y. Lin; C.-Y. Hui, *J. Rheology*, **46**, 273 (2002).
49. "Contact Mechanics Studies with the Quartz Crystal Microbalance" C.M. Flanigan; M. Desai; K.R. Shull, *Langmuir*, **16**, 9825 (2000).
50. "Contact Mechanics and the Adhesion of Soft Solids" K.R. Shull, *Mat. Sci. and Eng. R.*, **36**, 1 (2002).
51. "Bulk and Interfacial Contributions to the Deformation Mechanisms of Soft Adhesives: Extension to Large Strains" C. Creton; J. Hooker; K.R. Shull, *Langmuir*, **17**, 4948 (2001).
52. "Influence of Molecular Features on the Tackiness of Acrylic Polymer Melts" H. Lakrout; C. Creton; D. Ahn; K.R. Shull, *Macromolecules*, **34**, 7448 (2001).
53. "Adhesive and Mechanical Properties of Soft Nanocomposites: Model Studies with Blended Latex Films" E.F. Fabbroni; K.R. Shull; M.C. Hersam, *J. Polym. Sci. Polym. Phys.*, **39**, 3090 (2001).
54. "Microindentation and nanoindentation studies of aging in pressure-sensitive adhesives" A. Paiva; N. Sheller; M. Foster; A. Crosby; K. Shull, *Macromolecules*, **34**, 2269 (2001).
55. "Influence of Surface Ordering on the Wetting of Structured Liquids" R. Limary; P.F. Green; K.R. Shull, *Eur. Phys. J. E.*, **8**, 103 (2002).
56. "Thermoreversible Gelcasting: A Novel Ceramic Processing Technique" J.K. Montgomery; P.L. Drzal; K.R. Shull; K.T. Faber, *J. Amer. Ceramic Soc.*, **85**, 1164 (2002).
57. "Interfacial Activity of Gradient Copolymers" K.R. Shull, *Macromolecules*, **35**, 8631 (2002).
58. "An Axisymmetric Adhesion Test to Examine the Interfacial Interactions Between Biologically-Modified Networks and Models of the Extracellular Matrix" R.A. Stile; K.E. Healy; K.R. Shull, *Langmuir*, **19**, 1853 (2003).
59. "A Thermoreversible Gelcasting Technique for Ceramic Laminates" J.K. Montgomery; A.S. Botha; P.L. Drzal; K.R. Shull; K.T. Faber, *Scripta Mat.*, **48**, 785 (2003).

60. "Origins of mechanical strength and elasticity in thermally reversible, acrylic triblock copolymer gels" P.L. Drzal; K.R. Shull, *Macromolecules*, **36**, 2000 (2003).

61. "The Effects of Geometric Confinement on the Adhesive Debonding of Soft Elastic Solids" R.E. Webber; K.R. Shull; A. Roos; C. Creton, *Phys. Rev. E.*, **68**, 021805 (2003).

62. "Phase Segregation in Gradient Copolymer Melts" M.D. Lefebvre; M. Olvera de la Cruz; K.R. Shull, *Macromolecules*, **37**, 1118 (2004).

63. "Crosslinked hyaluronic acid hydrogels: a strategy to functionalize and pattern" T. Segura; B.C. Anderson; P.H. Chung; R.E. Webber; K.R. Shull; L.D. Shea, *Biomaterials*, **26**, 359 (2005).

64. "Synthesis of 3,4-dihydroxyphenylalanine (DOPA) containing monomers and their co-polymerization with PEG-diacrylate to form hydrogels" B.P. Lee; K. Huang; N. Nunalee; K.R. Shull; P.B. Messersmith, *J. Biomater. Sci. Polymer Ed.*, **15**, 449 (2004).

65. "Strain Dependence of the Viscoelastic Properties of Alginate Hydrogels" R.E. Webber; K.R. Shull, *Macromolecules*, **37**, 6153 (2004).

66. "Contact Mechanics Studies with the Quartz Crystal Microbalance: Origins of the Contrast Factor for Polymer Gels and Solutions." F.N. Nunalee; K.R. Shull, *Langmuir*, **20**, 7083 (2004).

67. "Adhesive bonding of glassy polymer surfaces by an ultrathin layer of a semicrystalline polymer" R.L. McSwain; K.R. Shull, *J. Polym. Sci., Polym. Phys.*, **42**, 3809 (2004).

68. "Deformation behavior of thin compliant layers under tensile loading conditions" K.R. Shull; C. Creton, *J. Polym. Sci., Polym. Phys. Ed.*, **42**, 4023 (2004).

69. "Dynamics of Polymer/Metal Nanocomposite Films at Short Times as Studied by X-ray Standing Waves" R.S. Guico; S. Narayanan; J. Wang; K.R. Shull, *Macromolecules*, **37**, 8357 (2004).

70. "Adhesive transfer of thin viscoelastic films" K.R. Shull; E.F. Martin; P.L. Drzal; M.C. Hersam; A. Markowitz; R. McSwain, *Langmuir*, **21**, 178 (2004).

71. "Thermodynamics of Polymer Blends Organized by Balanced Block Copolymer Surfactants Studied by Mean-Field Theories and Scattering" B.J. Reynolds; M.L. Ruegg; N.P. Balsara; C.J. Radke; T.D. Shaffer; M.Y. Lin; K.R. Shull; D.J. Lohse, *Macromolecules*, **37**, 7401 (2004).

72. "Nanoscale impedance microscopy-a characterization tool for nanoelectronic devices and circuits" L.S.C. Pingree; E.F. Martin; K.R. Shull; M.C. Hersam, *IEEE Trans. Nanotech.*, **4**, 255 (2005).

73. "Neurotrophin releasing single and multiple lumen nerve conduits" Y. Yang; L.D. Laporte; C.B. Rives; J.-H. Jang; W.-C. Lin; K. Shull; L.D. Shea, *J. Controlled Release*, **104**, 433 (2005).

74. "Elasticity, Fracture and Thermoreversible Gelation of Highly Filled Physical Gels" P.L. Drzal; K.R. Shull, *Eur. Phys. J. E*, **17**, 477 (2005).

75. "Adhesive Failure of Model Acrylic Pressure Sensitive Adhesives" P.L. Drzal; K.R. Shull, *J. Adhesion*, **81**, 397 (2005).

76. "Effect of sequence distribution on copolymer interfacial activity" M.D. Lefebvre; R.L. McSwain; C.M. Dettmer; C. Xu; J.R. Davila; R.J. Composto; S.T. Nguyen; K.R. Shull, *Macromolecules*, **38**, 10494 (2005).

77. "A contact mechanics method for characterizing the elastic properties and permeability of gels" C.-Y. Hui; Y.Y. Lin; F.-C. Chuang; K.R. Shull; W.-C. Lin, *Journal of Polymer Science, Part B: Polymer Physics*, **44**, 359 (2005).

78. "QCM Studies of Gel Spreading: Kraton Gels on Polystyrene Surfaces" F.N. Nunalee; K.R. Shull, *Langmuir*, **22**, 431 (2006).

79. "Quartz Crystal Microbalance Studies of the Contact between Soft, Viscoelastic Solids" M. Kunze; K.R. Shull; D. Johannsmann, *Langmuir*, **22**, 169 (2006).

80. "Cavity Nucleation and Delamination During Adhesive Transfer of a Thin Viscoelastic Film" R.L. McSwain; K.R. Shull, *J. Appl. Phys.*, **99**, 053533 (2006).

81. "Thickness and Interfacial Roughness Changes in Polymer Thin Films during X-Irradiation" A.G. Richter; R. Guico; K. Shull; J. Wang, *Macromolecules*, **39**, 1545 (2006).

82. "Rapid Gel Formation and Adhesion in Photocurable and Biodegradable Block Copolymers with High DOPA Content" B.P. Lee; C.-Y. Chao; F.N. Nunalee; E. Motan; K.R. Shull; P.B. Messersmith, *Macromolecules*, **39**, 1740 (2006).

83. "QCM Studies of Polymer Gels and Solutions in Liquid Environments" F.N. Nunalee; K.R. Shull; B.P. Lee; P.B. Messersmith, *Analytical Chemistry*, **78**, 1158 (2006).

84. "Perturbation to the resonance modes by gold nanoparticles in a thin-film-based x-ray waveguide" D.R. Lee; A. Hagman; X. Li; S. Narayanan; J. Wang, *Appl. Phys. Lett.*, **88**, 153101 (2006).

85. "Adhesive Contact of a Membrane with a Hemispherical Indenter: Theoretical Analysis and Model Liquid System" R.E. Webber; W.D.W. Cheng; K.R. Shull, *J. Adhesion*, **82**, 427 (2006).

86. "Contact Studies of Weakly Compressed PEG Brushes with a Quartz Crystal Resonator" D.A. Brass; K.R. Shull, *Langmuir*, **22**, 9225 (2006).

87. "Homopolymer Solubilization and Nanoparticle Encapsulation in Diblock Copolymer Micelles" M.D. Lefebvre; K.R. Shull, *Macromolecules*, **39**, 3450 (2006).

88. "Fracture and Adhesion of Elastomers and Gels: Large Strains at Small Length Scales" K.R. Shull, *J. Polym. Sci., Part B: Polym. Phys.*, **44**, 3436 (2006).

89. "Self-Assembly and Stress Relaxation in Acrylic Triblock Copolymer Gels" M.E. Seitz; W.R. Burghardt; K.T. Faber; K.R. Shull, *Macromolecules*, **40**, 1218 (2007).

90. "Self-assembly of acrylic triblock hydrogels by vapor-phase solvent exchange" M. Guvendiren; K.R. Shull, *Soft Matter*, **2**, 619 (2007).

91. "An Interfacial Curvature Map for Homopolymer Interfaces in the Presence of Diblock Copolymers" M.L. Nunalee; H. Guo; M. Olvera de la Cruz; K.R. Shull, *Macromolecules*, **40**, 4721 (2007).