NAME	POSITION TITLE
Rangaramanujam M. Kannan	Professor, Chemical Engineering and Materials Science, Biomedical Engineering
eRA COMMONS USER NAME (credential, e.g., agency login) aa2293	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Birla Institute of Technology and Science, India	B.E.	1987	Chemical Engg
Penn State University, Penn., USA	M.S.	1989	Chemical Engg
California Institute of Technology, USA	M.S.	1989	Chemical Engg
California Institute of Technology, USA	Ph.D.	1994	Chemical Engg

Research Interests

- Translational nanotechnology/nanomedine, Dendrimer-based targeted drug delivery
- Therapeutics/imaging approaches for neurodegenerative diseases: macular degeneration, cerebral palsy
- Targeted therapies for spinal cord injuries, infections/inflammation, maternal-fetal medicine
- Supercritical carbon dioxide processing of polymer nanocomposites: applications to barrier, packaging films, and foams, bone-graft substitutes
- Synthesis and characterization of dendrimer-based nanodevices and hydrogels

A. Positions and Honors.

Positions and Employment

1994-1995 Postdoctoral: Research Associate, Chemical Engineering,University of Minnesota
1995-1997 Senior Research Engineer, 3M Corporate Research Laboratories
1997-2003 Assistant Professor, Department of Chem. Engg. &Mat Sci., Wayne State University
2002-present Joint Appointment, Department of Biomedical Engg., Wayne State University
2003- present Associate Professor, Department of Chem. Engg. &Mat Sci., Wayne State University
2003-present Full Member, Barbara Ann Karmanos Cancer Institute, Detroit, Michigan
2004-2005 Co-founder & Research Director, nanoScience Engineering Corporation
5/2006-pre Vice President & Chief Technical Officer, nanoScience Engineering Corporation
5/2009-present Professor, Department of Chem. Engg. &Mat Sci., Wayne State University
9/07- present Director, NICHD Perinatology Research Branch-Nanotechnology Lab, Detroit, MI

Other Experiences and Professional Memberships

American Institute of Chemical Engineers (AIChE), American Academy of Nanomedicine

Honors

Du Pont Graduate Fellowship at Caltech (1989 – 1990)
Charles Lee Powell Foundation Graduate Fellowship at Caltech (1992-1994)
American Chemical Society Honor symposium for Unilever award (1995)
Unilever Award for outstanding Ph.D. thesis in polymer Science by ACS (1995)
Wayne State University Faculty Research Award (1997-1998, 1998-1999)

3M Non-tenured Faculty Award (1998 – 2000, 2001-2002)
NSF CAREER Award (1999)
Fellow, The American Academy of Nanomedicine, 2006-
Director, Nanotechnology Lab, NICHD Perinatology Research Branch, 2008-
NIH Study section membership (NCI Special Emphasis Panels, IMST W53 SBIR)
Editorial Board, NanoMedicine: Nanotechnology, Biology and Medicine

B.1 Selected peer-reviewed publications

[44] 'Dendrimer-Based Drug and Imaging Conjugates: Design Considerations for Nanomedical Applications', Invited Foundation review, *Drug Discovery Today*, R.M.Kannan, A.Menjoge, D.Tomalia, revised and submitted, Nov (2009)

[43] 'Stimuli-responsive star polyethylene glycol conjugates for improved intracellular delivery of N-acetyl cysteine in neuroinflammation', R. Navath, B.Wang, R.Romero, S.Kannan, R.M.Kannan, *J. Control. Release*, in press, (2009), doi:10.1016/j.jconrel.2009.10.035

[42] 'Multifunctional Dendrimer-templated Antibody Presentation on Biosensor Surfaces for Improved Biomarker Detection', H.Han, R.M.Kannan*, S.Wang, G.Z.Mao, J.P.Kusanovic, R.Romero, *Advanced Functional Materials*, in press, Oct (2009), 19, 1–13

[41] 'Drug release characteristics of PAMAM dendrimer–drug conjugates with different linkers', Y.E.Kurtoglu, M.Mishra, S.Kannan, R.M.Kannan*, *Int.J. Pharm*, 377(1-2), 159-168 (2009).

[40] 'Structure and mechanical properties of supercritical carbon dioxide processed porous resorbable polymer constructs, Baker, KC, R. Bellair, M. Manitiu, HN Herkowitz, RM Kannan*, *Journal of Mechanical Behavior of Biomedical Materials*, 2(6), 620-626 (2009).

[39] 'Enhanced delivery of N-acetyl cysteine to activated microglial cells using dendrimer-based nanodevices', B. Wang, R. Navath, R. Romero, S. Kannan, RM Kannan*, *Int.J. Pharm*, 377(1-2), 159-168 (2009)

[38] 'Effects of branching architecture and linker on the activity of hyperbranched polymer-drug conjugates', O. Perumal, J. Khandare, P. Kolhe, M. Lieh-Lai, S.Kannan, Kannan, RM*, web published, *Bioconjugate Chemistry* , 20(5),842-846 (2009), **Faculty of 1000 publication**.

[37] 'Role of Polymer-Clay Interactions and Nano-clay Dispersion on the Viscoelastic Response of a Series of $scCO_2$ Dispersed Clay/PVME Nanocomposites', Horsch, S, M. Manitiu, E. Gulari, RM. Kannan*****, Polymer, 50(15), 3786-3796 (2009).

[36] 'Drug release mechanisms and kinetics from dendrimer-drug conjugates with glutathione sensitive linkers', Emre, YK, R. Navath, B. Wang, R. Romero, S. Kannan, RM Kannan*,*Biomaterials*, 30, 2112-2121 (2009)

[35] 'Supercritical CO_2-processed dispersed polystyrene-clay nanocomposites', 'M. Manitiu, R. Bellair, S. Horsch, E. Gulari and R. M. Kannan*****, *Macromolecules*, 41,8038-8046, 2008

[34] 'Dendrimer-drug conjugates for tailored intracellular drug release based on glutathione levels', Navath, R; E. Turkoglu; B. Wang; S. Kannan;R. Romero; R.M. Kannan***,*** *Bioconjugate Chemistry*, 19, 2446-2455, 2008

[33] 'Engineering Strength, Porosity, and Emission Intensity of Nanostructured CdSe Networks by Altering the Building Block Shape", H. Yu, R. Bellair, RM.Kannan, S. Brock*, Journal of American Chemical Society, 130(15),5054-5055 (2008)

[32] 'Dendrimer Effect of surface functionality on the cellular trafficking of dendrimers', O. Pillai, R. Inapagolla, RM.Kannan, S.Kannan*, *Biomaterials* (2008), 29(24-25), 3469-3476 (2008)

[31] 'Preparation and characterization of PAMAM dendrimer-Streptokinase conjugates', X. Wang, Rajyalkshmi I, S. Kannan, R. M. Kannan, *Bioconjugate Chem*., 18(3), 791-799 (2007)

[30] 'Design and evaluation of dendritic nanodevices with high drug payload for enhanced cellular delivery', P. Kolhe, J. Khandare, O. Pillai, S. Kannan, M. Lieh-Lai, R. M. Kannan*****, *Biomaterials*, 27 (4): 660-669 FEB 2006

[29] 'Activity of dendrimer-methotrexate conjugates in sensitive and resistant cell lines', S. Gurdag, J. Khandare, S. Staples**,** R. M. Kannan***,** L. Matherly, Bioconjugate Chem. (2006), 17(2):275-83 ***(among the top 10 most accessed articles during that period, Faculty of 1000 publication, highlighted by NIH (Nano) and other publications)***

[28] 'Rheo-optical measurements of the first and third normal stresses of homopolymer polyvinyl methyl ether melt', A. Kulkarni, S. Kharchenko, R. M. Kannan***,** Rheologica Acta, (2006), 45(6), 951 (2006)

[27] 'Supercritical CO_2 dispersion of nanoclays and polymer-clay nanocomposites', S. Horsch, G. Serhatkulu, E. Gulari, R. M. Kannan*, *Polymer*, 47(21), 7485 (2006)

[26] 'Vibrational spectroscopic investigation of stereoregularity effects in syndiotactic polypropylene structure and morphology', M. Sevegney, R.M. Kannan***,** R. Naik, V. Naik, *Vibrational Spectroscopy*, 40 (2): 246-256 MAR 17 2006

[25] 'Synthesis, Cellular Transport and Activity of PAMAM Dendrimer-Methylprednisolone Conjugates', J. Khandare, P. Kolhe, O. Pillai, S. Kannan, M. Lieh-Lai, R. M. Kannan***,** *Bioconjugate Chemistry*, 16 (2), 330 -337, 2005

[24] 'Effect of dendrimer end functionality on the cytotoxicity and the cellular drug delivery in lung epithelial cells', S. Kannan, P. Kolhe, R. M. Kannan*****, M. Lieh-lai, M. Glibatec, Journal of Biomaterials Science: Polymers Edition, 15(3), 311 (2004)

[23] 'Novel streptokinase nanodevices for thrombolysis: preparation, in vitro, and in vivo studies, S. Kannan*, O. Pillai, RM Kannan, CHEST, 126(4), 878S (2004)

[22] 'Hyperbranched polymer-drug conjugates with high drug payload for enhanced cellular delivery' , P. Kolhe, J. Khandare, O. Pillai, S. Kannan, M. Lieh-Lai, R. M. Kannan***,** Pharm. Research, 21(12), 2185-2195 (2004)

[21] 'A rheo-optical FTIR spectrometer for the investigation of deformation behavior in complex polymers', M. Sevegney, G. Hofmann, R. M. Kannan*, Int. J. Poly. Anal. Char. 9, 245-274 (2004)

[20] 'Role of architecture on the conformation, rheology, and orientation behavior of linear, star, and hyperbranched polymer melts: 1. Synthesis and Molecular Characterization' by S. Kharchenko, R. M. Kannan***,** J.Cernohous, and S. Venkataramani, Macromolecules, 36(2), 399-406 (2003)

[19] 'Role of architecture on the conformation, rheology, and orientation behavior of linear, star, and hyperbranched polymer melts: 2. Linear viscoelasticity and flow birefringence' by S. Kharchenko and R. M. Kannan***,** Macromolecules, 36(2), 407-415 (2003)

[18] 'Drug complexation, in vitro release, and cellular entry by dendrimers and hyperbranched polymers', P. Kohle, E. Misra, R. M.Kannan*, S. Kannan, M. Lieh-Lai, International Journal of Pharmaceutics, 259, 143-160 (2003) **(top 10 most accessed articles of the journal in 2003), cited more than 100 times**

[17] 'Improvement in ductility of chitosan through blending and copolymerization with PEG: FTIR investigation of molecular interactions ', P. Kolhe and R. M. Kannan*, Biomacromolecules, Vol. 4 (1), 173-180 (2003)

[16] 'Deformation-induced morphology changes and orientation behavior in syndiotactic polypropylene', M. Sevegney, G. Parthasarthy, R. M. Kannan***,** Macromolecules, 36(17), 6472 (2003)

[15] 'Rheo-optical FTIR Spectroscopy of the deformation behavior in quenched and slow-cooled isotactic polypropylene films', G. Parthasarthy, M. Sevegney, R. M. Kannan***,** J. Poly. Sci. (Poly. Phys.), 40(22), 2539-2551 (2002)

[14] 'Unusual contributions of molecular architecture to rheology and flow birefringence in hyperbranched polystyrene blends', S. Kharchenko, R. M. Kannan***,** J. Cernohous, S. Venkataramani, G. Babu, J. Poly. Sci (Poly.Phys), 39, 2562 (2001)

[13] 'Effect of composition fluctuations on tracer diffusion in symmetric diblock copolymers', R. M. Kannan, T. P. Lodge & J. Su, *J. Chem. Phys.*, 108(11), 4634-4639 (1998)

[12] 'Diffusion in block copolymer microstructures', T. P. Lodge, M. Hamersky, J. Milhaupt, R. M. Kannan, M. C. Dalvi, and C. Eastman, *Macromolecular Chem. & Phy*., *Macro.Symp*., Vol. 121, 219 (1997)

[11] 'Viscoelastic properties of highly entangled poly(vinyl methyl ether', R. M. Kannan, T. P. Lodge, *Macromolecules*, Vol.30 (12), 3694-3695 (1997)

[10] 'Dynamics of disordered diblocks of polyisoprene and polyvinylethylene', B. H. Arendt, R. Krishnamoorti, R. M. Kannan, K. Seitz, J. A. Kornfield & J. Roovers, *Macromolecules*, 30 (4), 1138-1145 (1997)

[9] 'Effect of mesophase order and molecular weight on the dynamics of nematic and smectic side - group liquid - crystalline polymers, S. F. Rubin, R. M. Kannan, J. A. Kornfield, & C. Boeffel, *Macromolecules*, Vol. 28(10), 3521 (1995)

[8] 'Evolution of microstructure and viscoelasticity during flow alignment of a lamellar diblock copolymer', R. M. Kannan & J. A. Kornfield, *Macromolecules*, Vol. 27, 1177-1186 (1994)

[7] 'Stress - optical manifestations of molecular and microstructural dynamics in complex polymer melts', R. M. Kannan & J. A. Kornfield, invited paper, *Journal of. Rheology*, Vol. 38(4), 1127-1150 (1994)

[6] 'Dynamics of flow-alignment in side-group liquid-crystalline polymers', R. M. Kannan, S. F. Rubin, J. A. Kornfield, & C. Boeffel, invited paper, *J. Rheology*, 38(5), 1609-1622 (1994)

[5] 'Shear orientation in side-group liquid - crystalline polymers', R. M. Kannan, J. A. Kornfield, N. Schwenk, & C. Boeffel, *Advanced Materials*, Vol. 6, 214-216 (1994)

[4] 'Dynamics of each component in miscible blends of polyisoprene and polyvinylethylene', R. M. Kannan, B. H. Arendt, M. Zewail, & J. A. Kornfield, *Rheologica Acta*, Vol.33, 322-336 (1994)

[3] 'Rheology of side-group liquid-crystalline polymers:effect of isotropic-nematic transition and evidence of flow alignment', R. M. Kannan, J. A. Kornfield, N. Schwenk, & C. Boeffel, *Macromolecules*, Vol. 26, 2050 - 2056 (1993)

[2] 'Some thoughts on graduate education-A graduate student's perspective', R. M. Kannan, *Chemical Engineering Education*, Fall (1992)

[1] 'The third normal stress difference in entangled melts: quantitative stress-optical measurements in oscillatory shear', R. M. Kannan & J. A. Kornfield, *Rheologica Acta*,Vol.31, 535-544 (1992)

B.2 Manuscripts under journal review

[45] 'In vitro and in vivo antimicrobial activities of PAMAM dendrimers with different surface functional groups', B. Wang, R.Navath, A.Menjoge, B.Balakrishnan, R.Bellair, H.Dai, R.Romero, S.Kannan, R.M.Kannan, under review, *Biomaterials*, October (2009)

[46] 'Amino Acid functionalized Dendrimers with Hetero-bifunctional Chemoselective Peripheral groups for Drug Delivery', R.Navath, A.Menjoge, B.Wang, R.Romero, S.Kannan, R.M.Kannan, submitted, *J. Amer.Chem.Soc.*, Nov (2009)

[47] 'Investigation of clay modifier effects on the structure and rheology of supercritical carbon dioxide-processed polymer nanocomposites', R.Bellair, M.Manitiu, E.Gulari, R.M.Kannan, J.Polymer Sci. (Poly.Phys.), revised/submitted, November, 2009

[48]' Intrinsic targeting of neuroinflammation by polyamidoamine dendrimers in a rabbit model of cerebral palsy' H.Dai, R.Navath, B.Balakrishnan, B.Raja Guru, M.Mishra, R.Romero, S.Kannan, R.M.Kannan, submitted, *Future Medicine:Nanomedicine*, Nov. (2009)

[49] 'Structure, mechanical properties and biocompatibility of supercritical CO_2-processed resorbable polymer nanocomposites', K.Baker, R.Bellair, M.Manitiu, C.Grattop, H.Herkowitz, R.M.Kannan, submitted, *Biomaterials*, Nov (2009).

[50] 'Synthesis, characterization, and intracellular uptake of hydroxyl-terminated poly(amidoamine) dendrimer-erythromycin conjugates', A.Bosnjakovic, M.Mishra, Y.E. Kurtoglu, W.Ren, R M. Kannan, submitted, Bioconjugate Chem., Nov (2009)

B.3. Patents

(1) Dendrimer-containing particles for sustained release of compounds, R. Kannan, R. Iezzi, S. Kannan, US patent filed 10/5/07 (Application #60/997987)/International patent filed Oct 2008 (application #, PCT/US2008/078988).

(2) 'Supercritical Fluid based process for preparing highly exfoliated nanocomposites', E. Gulari, G.K. Serhatkulu, R. M. Kannan, US patent awarded, 7,387,749, 2007 (spinoff company, RM Kannan-CTO)

(3) Method for aligning side-group liquid-crystalline polymers", J. A. Kornfield, R. M. Kannan, N. Schwenk, US patent, 5,313,320 (1994)

(4) Dendrimer-based nanodevices for maternal-fetal applications, R. Kannan, S. Kannan, R.Romero, R. Navath, H. Dai, Y. Kurtoglu, B.Wang, A. Menjoge, Provisional patent filed with very significant in vivo data, cluster of patents will emerge.

(5) Amino-acid functionalized bifunctional dendrimers for drug delivery and microbiological applications, R. Kannan, R. Navath, S. Kannan, R. Romero, B.Wang, Invention disclosed.

(6) Novel polylactic acid containing clay nanocomposite foams for medical applications, R.M.Kannan, K. Baker, M.Manitiu, R.Bellair, Invention disclosed, significant venture interest expressed on this invention.

Ongoing Research Support

1. Title: “Dendrimer-based functionally-optimized nanodevices for diagnosis and treatment of chorioamnionitis”
Role: PI (~70% share); S. Kannan (co-PI)(~30% share)
% Effort: 50%
Agency: NICHD-Perinatology Research Branch (sub contract)
Performing Period: 9/07— 10/2010 (renewable yearly)
Amount: ~$2,400,000 (for three years, renewable yearly)
Project goal: Preparation, in vitro and in vivo characterization of PAMAM dendrimer-based therapeutic, imaging and targeting nanodevices. Animal evaluation of efficacy in pregnant rabbit and guinea pig models.

2. Title: “In vivo evaluation of dendrimer nanodevices for neuroinflammation
Role: PI (34% share) ; co-Is: R. Iezzi (33%) and S. Kannan (33%)
Agency: Ralph C. Wilson Foundation for Biomedical Engg.
Performing Period: 1/08—512/10
Project goal: Develop dendrimer-minocycline nanodevices for in vivo testing in rat model of retinal degeneration and rabbit model of cerebral palsy

3. Title: “Dendrimer-based ocular nanotherapeutics”
Role: PI
Time Commitment: 5%
Agency/Company: Dryer Foundation
Performing Period:1/09–12/31/09
Level of Funding: $75,000 (per year, renewable)
Project goal: Preparation and in vivo characterization of dendrimer-drug nanodevices for intravitreal Delivery

4. Title: “Systemically Delivered Dendrimer Drug Nanodevices for the Targeted Treatment of Trauma-Associated Retinal Neuroinflammation and Degeneration”
Role: co-PI (50%); R.Iezzi:co-PI (50%)
Agency: DoD CDMRP Hypothesis Development Award (awarded at the 5th percentile/replaced)
Performing Period: 2/10-8/11
Amount: ~$225,000
Project goal: Development of dendrimer-resolvin intravitreal drug delivery systems

5. Title: “Development and characterization of polymer Clay nanocomposites” (NSF SBIR Phase II subcontract)
Role: PI
Source: nanoScience Engineering Corp (NSF SBIR Phase II subcontract)
Amount: $116,000
Duration: 9/06 – 12/09

External Funding (Pending Proposals)

1. Project Title: Wayne State University Obstetrics Pharmacology Research Unit
Role: co-investigator (Concept project) (PI: S.Kannan); Program Director: D.Chugani
Source: US Army-DoD, Synergistic Idea Award (Breast Cancer Program)
Amount: $4,855,254 (Kannan(s) part: ~$1, 875,000)
Duration: 12/09 – 11/14

2. Title: “Functional plasticity in the mammalian spinal cord”
Role: co-I (20% share, 15% effort); PI: H.Goshgarian (40% effort, 80% share)
Agency: NIH R01
Performing Period: 7/10-6/15
Amount: $2,883,928
Project goal: Development of dendrimer-theophylline nanodevices for breathing recovery after spinal cord injuries

D.1 Graduate Student Advised: 10 PhDs and 3 MS

Semen Kharchenko (**Ph.D.** in ChE - October 2001)
Vivek Maheshwari (**M. S**. ChE (Thesis) – September 2001)
Gautam Parthasarthy (**M. S**. MSE (Thesis) – August 2001)
Ekta Misra (**M. S**. MSE (Thesis) – July 2001)
Parag Kolhe (**Ph.D**. MSE – April 2004)
Michael Sevegney (**Ph.D**. ChE – April 2004)
Sezen Gurdag (**Ph.D**. – May 2005)
Ajay Kulkarni (**Ph.D.** – May 2006)
Rajyalakshmi Inapagolla (**Ph.D** – December 2006)
Steve Horsch {**Ph.D.**- June 2006 (with E. Gulari)}
Bharath Raja Guru (**Ph.D.,** December 2008)
Yunus Emre Kurtoglu (**Ph.D.** August 2009)
Robert Bellair (**Ph.D**. November 2009)

D.2 Graduate Students - Current

Mihai Manitou (Ph.D. candidate – 4th Year) - expected graduation 5/10
Kevin Baker (Ph.D. Student, BME – 3rd year)
Admira Bosjanovic (PhD student-MSE, 3rd year)

D.3 Current Post-doctoral Associates:

Manoj Mishra (10/2007-current)
Hye-Jung Han (9/2007 – current)
Raghavendra Navath (7/2007-current)
Anupa Menjoge (3/09 – current)
Hui Dai, MDPhD (10/2007-current)(joint with S. Kannan)
Bing Wang, MDPhD (10/2007-current)(joint with S.Kannan)

E. <u>Synergistic Activities</u>

1. Developing a Center for Nanomedicine (as director) at Wayne State, with collaborators from colleges of science, engineering, School of Medicine, Children's Hospital of Michigan, NICHD Perinatology Research Branch, Karmanos Cancer Institute, OB & Gyn department, Immunology & Microbiology, Anatomy, and Orthopedic surgery, constituing more than 25 basic science, engineering, clinical and medical researchers.

2. Developing a Graduate Certificate Program in Nanotechnology and Nanomedicine which will be offered to students from the colleges of engineering, science, medicine and pharmaceutical sciences, with a multidisciplinary curriculum
3. R. Romero (Director, NICHD Perinatology Research Branch), S. Kannan (Pediatric Critical Care): Development and translation of dendrimer-based nanodevices for maternal-fetal applications in diagnosis, treatment and imaging.

4. Mary Lieh-lai MD (Pediatric Critical Care), David Bassett PhD (Occupational Health and Pharmacy), M. Glibatec PhD (Pediatrics), Wayne State University School of Medicine, Children's Hospital of Michigan, 'Animal model and cellular studies on drug-dendrimer complexes', 'Applications to Asthma, and Thrombolysis'

5. Ray Iezzi (Kresge Eye Institute), S. Kannan (Children's Hospital of Michigan) – "Dendrimer-based drug delivery for neuroinflammation and PET imaging"

6. Weiping Ren, Biomedical Engineering and Orthopedic Surgery, "Dendrimer-based therapeutic approaches for the treatment of orthopedic inflammation

7. Harry Goshgarian, "Retrograde delivery of dendrimer-drug nanodevices for breathing recovery after spinal cord injuries"

8. Larry Matherly, Anthony Shields, Fazlul Sarkar (Barbara Ann Karmanos Cancer Institute)**,** 'Tailored dendritic nanostructures for cancer therapy'

9. Michael Diamond, G.Saed, Ray Novak (WSU Medical School) Dendrimer-based siRNA delivery"