
BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
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| NAME Arruda, Ellen M. | POSITION TITLE Professor of Mechanical Engineering Professor of Macromolecular Science and Engineering | | |
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| eRA COMMONS USER NAME arruda | | | |
| EDUCATION/TRAINING <i>(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)</i> | | | |
| INSTITUTION AND LOCATION | DEGREE <i>(if applicable)</i> | YEAR(s) | FIELD OF STUDY |
| Pennsylvania State University | B.S. (Honors) | 1985 | Engineering Science |
| Pennsylvania State University | M.S. | 1988 | Engineering Mechanics |
| Massachusetts Institute of Technology | Ph.D. | 1992 | Mechanical Engineering |

A. Positions and Honors

Positions Held

Professor, Mechanical Engineering, University of Michigan, 2005 to present.
Professor, Macromolecular Science and Engineering, University of Michigan, 2005 to present.
Associate Professor, Mechanical Engineering, University of Michigan, Sept. 1999 to 2005.
Associate Professor, Macromolecular Science and Engineering, University of Michigan, Sept. 1999 to 2005.
Assistant Professor, Mechanical Engineering, University of Michigan, Sept., 1992 to Aug., 1999.
Assistant Professor, Macromolecular Science and Engineering, University of Michigan, Sept. 1992 to 1999.
Visiting Assistant Professor, Mechanical Engineering, University of Michigan, August, 1992 to Sept., 1992.
Research Assistant, Mechanical Engineering, Massachusetts Inst. of Technology, Sept. 1988 to July, 1992.
Research Assistant, Engineering Science & Mechanics, Penn State University, August, 1985 to August, 1988

Honors and Awards

Fellow, American Society of Mechanical Engineers, 2008
Fellow, Society of Engineering Science, 2008
Outstanding Research Award, College of Engineering, University of Michigan, 2006-2007
Centennial Fellow, Department of Engineering Science and Mechanics, The Pennsylvania State University, 2006
Outstanding Achievement Award, ME Department, University of Michigan, 2004
NSF CAREER Award, 1997-2001
3M Untenured Faculty Research Award, 1997-2000
Career Development Award, University of Michigan, 1995
Outstanding Teaching Award, MEAM Department, University of Michigan, 1995
General Electric Junior Faculty Fellowship, 1993
B. S. with Honors, The Pennsylvania State University, 1985
Chamberlain Manufacturing Corporation Scholarship, 1981-1985
Member of *Tau Beta Pi* (National Engineering Honor Society)

Professional Service

Member, Board of Editors, Cellular and Molecular Bioengineering, 2007-present
Member, Board of Editors, Molecular and Cellular Biomechanics, 2007-present
Associate Editor, *ASME Journal of Biomechanical Engineering*, 2005-present
Associate Editor, *ASME Journal of Applied Mechanics*, 2001-2007
President, Society of Engineering Science, 2004
Vice President, Society of Engineering Science, 2003
Member, Board of Directors, Society of Engineering Science, 1999-2005

B. Selected Peer-Reviewed Publications

Selected Journal Publications

1. Smietana, M.J., Syed-Picard, F.N., Ma, J., Kostrominova, T.Y., Arruda, E.M., and Larkin, L.M., "The Effect of Implantation on Scaffoldless Three-Dimensional Engineered Bone Constructs," *In Vitro Cellular and Developmental Biology – Animal*, in review, 2009.
 2. Kaushik, A.K., Podsiadlo, P., Qin, M., Shaw, C.M., Waas, A.M., Kotov, N.A., and Arruda, E.M., "The Role of Nanoparticle Separation in the Finite Deformation Response of Polyurethane-Clay Nanocomposites," *Journal of Advanced Functional Materials*, in review, 2009.
 3. Ma, J., Goble, K., Smietana, M., Kostrominova, T.Y., Larkin, L.M., and Arruda, E.M., "Morphological and Functional Characteristics of Three-Dimensional Engineered Bone-Ligament-Bone Constructs Following Implantation," *Journal of Biomechanical Engineering*, in review, 2008.
 4. Garikipati, K., Olberding, J.E., Arruda, E.M. and Thouless, M.J., "A Theoretical Study of Thermodynamic Driving Forces and Kinetics of Focal Adhesion Growth," in review, 2008.
 5. Podsiadlo, P., Arruda, E.M., Kheng, E., Waas, A.M., Lee, J., Critchley, K., Qin, M., Kaushik, A.K., Kim, H-S., Qi, Y., Noh, S-T., and Kotov, N.A., "Hierarchically-Structured Layer-by-Layer Assembled Laminates as Macroscale High-Toughness Materials," *Nature Materials*, in review, 2008.
 6. Podsiadlo, P., Kaushik, A.K., Shim, B.B., Agarwal, A., Tang, Z., Waas, A.M., Arruda, E.M., and Kotov, N.A., "Can Nature's Design be Improved Upon? High Strength Nacre-Like Nanocomposites," *Journal of Physical Chemistry B*, Vol. 112, N:46, pp 14359-14363, 2008.
 7. Podsiadlo, P., Kaushik, A.K., Arruda, E.M., Waas, A.M., Shim, B.S., Xu, J., Nandivada, H., Pumplun, B.G., Lahann, J. Ramammorthy, A., and Kotov, N.A., "Ultrastrong and Stiff Layered Polymer Nanocomposites," *Science*, Vol. 318, pp 80-83, 2007.
 8. Syed-Picard, F.N., Larkin, L.M., Shaw, C.M., and Arruda, E.M., "Engineered Functional Bone from Bone Marrow Stromal Cells and Their Autogenous Extra-Cellular Matrix," *Tissue Engineering*, Vol. 15, No. 1, pp 187-195, 2009.
 9. Kostrominova, T.Y., Calve, S.C., Arruda, E.M., and Larkin, L.M., "Ultrastructure of Myotendinous Junctions in Tendon-Skeletal Muscle Constructs Engineered *in vitro*," to appear in *Histology and Histopathology*, 2009.
 10. Narayanan, H., Arruda, E.M., Grosh, K., and Garikipati, K., "The Micromechanics of Fluid-Solid Interactions During Growth in Porous Soft Biological Tissue," to appear in *Biomechanics and Modeling in Mechanobiology*, 2008.
 11. Arruda, E.M., Mundy, K., Calve, S.C. and Baar, K., "Denervation Does Not Change the Ratio of Collagen I and Collagen III mRNA in the Extracellular Matrix of Muscle," *AJP: Regulatory, Integrative and Comparative Physiology*, Vol. 292, pp R983-R987, 2007.
 12. Wang, Y. and Arruda, E.M., "Constitutive Modelling of a Thermoplastic Olefin (TPO) over a Broad Range of Strain Rates," *Journal of Engineering Materials Technology*, Vol. 128, No. 4, pp 551-558, 2006.
 13. Larkin, L., Calve, S.C., Kostrominova, T.Y., and Arruda, E.M., "Structure and Functional Evaluation of Tendon-Skeletal Muscle Constructs Engineered *In Vitro*," *Tissue Engineering*, Vol. 12, No. 11, pp 3149-3158, 2006.
 14. Arruda, E.M., Mundy, K., Calve, S.C., and Baar, K., "Regional Variation of Tibialis Anterior Tendon Mechanics is Lost Following Denervation," *Journal of Applied Physiology*, Vol. 53, No. 4, pp 1113-1117, 2006.
 15. Garikipati, K., Olberding, J.E., Narayanan, H., Arruda, E.M., Grosh, K. and Calve, S., "Biological Remodelling: Stationary Energy, Configurational Change, Internal Variables and Dissipation," *Journal of the Mechanics and Physics of Solids*, Vol. 54, No. 7, pp 1493-1515, 2006.
 16. Kuhl, E., Garikipati, K., Arruda, E.M. and Grosh, K., "Remodeling of Biological Tissue: Mechanically Induced Reorientation of a Transversely Isotropic Chain Network," *Journal of the Mechanics and Physics of Solids*, Vol. 53, No. 7, pp 1552-1573, 2005.
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17. Wu, Z., Ahzi, S., Arruda, E.M., and Makradi, A., "Modeling the Large Inelastic Deformation Response of Non-Filled and Silica Filled SL5170 Cured Resin," *Journal of Materials Science*, Vol. 40, No. 17, pp 4605-4612, 2005.
 18. Borschel, G.H., Huang, Y.C., Calve, S.C., Arruda, E.M., Lynch, J.B., Dow, D.E., Kuzon, W.M., Dennis, R.G., and Brown, D.L., "Tissue Engineering of Recellularized Microvascular Grafts," *Tissue Engineering*, Vol. 11, No. 5-6, pp 778-786, 2005.
 19. Baar, K., Birla, R., Boluyt, M. O., Borschel, G. H., Arruda, E. M., and Dennis, R. G., "Heart Muscle by Design: Self-Organization of Rat Cardiac Cells into Contractile 3D Cardiac Tissue," *Federation of American Societies for Experimental Biology Journal*, Feb. 19(2):275-277, 2005.
 20. Xu, W., Martin, D.C., and Arruda, E.M., "Finite Strain Response, Microstructural Evolution and β to α Phase Transformation of Crystalline Isotactic Polypropylene," *Polymer*, Vol. 46, pp 455-470, 2005.
 21. Bischoff, J.E., E.M. Arruda and K. Grosh, "A Rheological Network Formulation for Orthotropic Viscoelasticity in Soft Tissue," *Biomechanics and Modeling in Mechanobiology*, Vol. 3, No. 1, pp 56-67, 2004.
 22. Garikipati, K., Narayanan, H., Arruda, E.M., Grosh, K., and Calve, S.C., "Material Forces in the Context of Biotissue Remodelling," Available at arxiv.org/PS_cache/q-bio/pdf/0312/0312002.pdf
 23. Garikipati, K., Arruda, E.M., Grosh, K., Narayanan, H., and Calve, S.C., "A Continuum Treatment of Growth in Biological Tissue: Mass Transport Coupled with Mechanics," *Journal of the Mechanics and Physics of Solids*, Vol. 52, No. 7, pp 1595-1625, 2004.
 24. Calve, S.C., Dennis, R. G., Kosnik, P., Baar, K., Grosh, K., and Arruda, E.M., "Engineering of Functional Tendon," *Tissue Engineering*, Vol. 10, No. 5/6, pp 755-761, 2004.
 25. Ahzi, S., Ganesan, A., and Arruda, E. M., "Modeling Simulation of Deformation Texture in Semi-Crystalline Polymers: Application to Polypropylene and Nylon-6," *Materials Science Forum*, Vols. 408-412, pp 1723-1728, 2002.
 26. Bischoff, J. E., Arruda, E. M. and Grosh, K., "Finite Element Simulations of Nonlinear Orthotropic Hyperelasticity," *Finite Elements in Analysis and Design*, Vol. 38, pp 983-998, 2002.
 27. Bischoff, J. E., Arruda, E. M., and Grosh, K., "Orthotropic Hyperelasticity in Terms of an Arbitrary Molecular Chain Model," *Journal of Applied Mechanics*, Vol. 69, pp 199-201, March 2002.
 28. Bischoff, J. E., Arruda, E. M., and Grosh, K., "A Microstructurally Based Orthotropic Hyperelastic Constitutive Law," *Journal of Applied Mechanics*, Vol. 69, pp. 570-579, September 2002.
 29. P. R. von Lockette and E. M. Arruda, "Mesoscale Modeling of Bimodal Elastomer Networks: Constitutive and Optical Theories and Results," *Macromolecules*, Vol. 35, No. 18, pp. 7100-7109, 2002.
 30. M. C. Boyce and E. M. Arruda, "Swelling and Mechanical Stretching of Elastomeric Materials," *Mathematics and Mechanics of Solids*, Vol. 6, pp 641-659, 2001.
 31. Bischoff, J. E., Arruda, E. M., and Grosh, K., "A New Constitutive Model for the Compressibility of Elastomers at Finite Deformations," *Rubber Chemistry and Technology*, Vol. 74, No. 4, pp 541-559, September-October, 2001.
 32. P. R. von Lockette and E. M. Arruda, "Computational Annealing of Simulated Unimodal and Bimodal Networks," *Computational and Theoretical Polymer Science*, Vol. 11, No. 6, pp. 415-428, 2001.
 33. Y. Wang, E. M. Arruda, and P. A. Przybylo "Characterization and Constitutive Modeling of a Plasticized Polyvinylchloride for a Broad Range of Strain Rates," *Rubber Chemistry and Technology*, Vol. 74, No. 4, pp 560-573, September-October, 2001.
 34. M. C. Boyce and E. M. Arruda, "Constitutive Models of Rubber Elasticity: A Review," *Rubber Chemistry and Technology*, Vol. 73, pp 504-523, 2000.
 35. P.A. Przybylo, E.M. Arruda, and C.C. Chou, "Experimental Investigation of Plasticized Polyvinylchloride Using the Split Hopkinson Bar Technique," selected for SAE 2000 Transactions: Journal of Passenger Car - Mechanical Systems, v. 109, 2000. (Presented as SAE Paper 2000-01-0610, SAE International Congress and Exposition, Detroit, MI, March 6-9, 2000; and included in Safety Test Methodologies, SAE Special Publication 1516, 2000.)
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36. Bischoff, J.E., E. M. Arruda and K. Gosh, "Finite Element Modelling of Human Skin using a Non-Linear Elastic Constitutive Model," *Journal of Biomechanics*, Vol. 33 pp 645-652, 2000.
 37. X. Lu, E. M. Arruda and W. W. Schultz, "The Effect of Process Parameters on Glass Fiber Birefringence Development and Relaxation," *Journal of Non-Newtonian Fluid Mechanics*, Vol. 86, pp 89-104, 1999.
 38. P. R. von Lockette and E. M. Arruda, "Topological Studies of Bimodal Networks," *Macromolecules*, Vol. 32, No. 6, pp 1990-1999, 1999.
 39. P. R. von Lockette and E. M. Arruda, "A Network Description of the Non-Gaussian Stress-Optic and Raman Scattering Responses of PDMS Networks," *Acta Mechanica*, Vol. 134, pp 81-107, 1999.
 40. P. A. Przybylo and E. M. Arruda, "Experimental Investigations and Numerical Modelling of Incompressible Elastomers during Non-Homogeneous Deformations," *Rubber Chemistry and Technology*, Vol. 71, No. 4, pp 730-749, 1998.
 41. E. M. Arruda, S. Ahzi, Y. Li, and A. Ganesan, "Rate Dependent Deformation of Semi-Crystalline Polypropylene Near Room Temperature," *ASME Journal of Engineering Materials and Technology*, Vol. 119, No. 3, pp 216-222, 1997.
 42. G. K. Gupta, W. W. Schultz, E. M. Arruda, and X. Lu, "Nonisothermal Model of Glass Fiber Drawing Stability," *Rheologica Acta*, Vol. 35, pp 584-596, 1996.
 43. E. M. Arruda and P. A. Przybylo, "An Investigation into the Three Dimensional Stress-Birefringence-Strain Relationship in Elastomers," *Polymer Engineering and Science*, Vol. 35, No. 5, pp 1-8, 1995.
 44. E. M. Arruda, M. C. Boyce, and R. Jayachandran, "Effects of Strain Rate, Temperature and Thermomechanical Coupling on the Finite Strain Deformation Response of Glassy Polymers," *Mechanics of Materials*, Vol. 19, pp 193-212, 1995.
 45. M. C. Boyce, E. M. Arruda and R. Jayachandran, "The Large Strain Compression, Tension and Simple Shear of Polycarbonate," *Polymer Engineering and Science*, Vol. 34, No. 9, pp 716-725, 1994.
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 47. E. M. Arruda and M. C. Boyce, "Evolution of Plastic Anisotropy in Amorphous Polymers During Finite Straining," *International Journal of Plasticity*, Vol. 9, No. 6, pp. 697-720, 1993.
 48. E. M. Arruda and M. C. Boyce, "A Three-Dimensional Constitutive Model for the Large Stretch Behavior of Rubber Elastic Materials," *Journal of the Mechanics and Physics of Solids*, Vol. 41, No. 2, pp. 389-412, 1993.
 49. M. C. Boyce and E. M. Arruda, "An Experimental and Analytical Investigation of the Large Strain Compressive and Tensile Response of Glassy Polymers," *Polymer Engineering and Science*, Vol. 30, No. 20, pp. 1288-1298, 1990.
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Other Support

N00014-06-1-0473 (Arruda) 03/16/06 – 09/01/09
Sponsor: Office of Naval Research \$867,032 1.2 academic
Title: Basic Research in the Inherent Toughening Mechanisms in Polymeric Materials at High Strain Rates
Goal: To design lightweight nanocomposites with superior toughness under impact conditions.

R21 AR054359 (Larkin) 03/06/06 – 02/28/09
Sponsor: National Institutes of Health \$107,500 1.8 academic
Title: “Electromechanical Stimuli on the Development of Engineered Myotendinous Junction”
Goal: To engineer and characterize 3-dimensional muscle-tendon constructs and evaluate in vitro interventions on the advancement of the phenotype of the construct.

R01 AR054778 (Larkin) 04/11/07 - 01/31/12
Sponsor: National Institutes of Health \$250,000 1.8 academic
Title: “Engineering Innervated Muscle-Tendon Constructs for Tissue Regeneration”
Goal: To engineer and characterize 3-dimensional muscle-nerve constructs and evaluate in vitro and in vivo interventions on the advancement of the phenotype of the construct.

R01 AR055624 (Brooks) 07/01/08 – 06/30/13
Sponsor: National Institutes of Health \$250,000 1.2 academic
Title: Mechanisms Underlying Mechanical Properties of Muscle-Tendon Units
Purpose: To clarify the mechanisms underlying regional differences in mechanical properties along tendons and changes in mechanical properties with aging, and to determine the impact of tendon changes on muscle function and susceptibility to injury.

(Arruda) 04/15/08 – 04/14/09
Sponsor: Office of Naval Research \$354,597 0.0 academic
Title: “Structural and Mechanical Characterization Equipment for Advanced Impact-Resistant Nanocomposites”
Purpose: To probe the deformation mechanisms in polymers at the nanoscale.
