

## Faculty - Markus J. Buehler

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Biosketch Markus J. Buehler ([link to PDF...](#))

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### Education

- Postdoctoral Scholar, 2004-2005; Division of Chemistry and Chemical Engineering, California Institute of Technology
- Ph.D. (Dr. rer. nat.) 2004 in Materials Science (Chemistry), Max Planck Institute for Metals Research at the University of Stuttgart
- M.S. 2001 in Engineering Mechanics, Michigan Tech
- B.S. equiv./pre-diploma 2000 in Process and Chemical Engineering, University of Stuttgart

### Editorial Activities

- Member, Editorial Board, Computational Materials Science
- Section Editor, Nanotechnology (Institute of Physics)
- Associate Editor, J. Engineering Mechanics (American Society of Civil Engineers)
- Academic Editor, PLoS ONE
- Member, Editorial Board, Journal of Nanomechanics and Micromechanics
- Executive Editor, International Journal of Applied Mechanics
- Editorial Board, Journal of the Mechanical Behavior of Biomedical Materials
- Editor, Acta Mechanica Sinica
- Associate Editor, Journal of Computational and Theoretical Nanoscience

### Research Interests

Materials science and mechanics of natural and biological protein materials (materiomics), how protein materials define our body and how they fail catastrophically (fracture, deformation, disease), large-scale atomistic modeling, protein based materials and biopolymers, interaction of

chemistry and mechanics, bridging chemical scales to continuum theories of materials, modeling of bio-nano-materials phenomena, multiple-scale simulation, development and use of multi-scale simulation tools.

### Teaching Interests

- MIT Professional Education: Materials By Design ([http://web.mit.edu/professional/short-programs/courses/materials\\_by\\_desi...](http://web.mit.edu/professional/short-programs/courses/materials_by_desi...))
- Mechanics of materials, materials science, multi-scale modeling and simulation, biomechanics, molecular mechanics.
- Subjects taught:
  - 1.021J Introduction to Modeling and Simulation
  - 1.050 Engineering Mechanics I
  - 1.545 Atomistic Modeling and Simulation of Materials and Structures
  - 2.797J Molecular-, Cellular-, and Tissue-Biomechanics (guest instructor)
  - 3.320 Atomistic Modeling of Materials (guest instructor)
  - 3.22 Mechanical Properties of Materials
  - 1.978 From Nano to Macro: Introduction to Atomistic Modeling Techniques

### Awards and Honors

- TMS Hardy Award 2013
- JOM Best Paper Award 2013
- IEEE Holm Conference Mort Antler Lecture Award, 2012
- Society of Engineering Science Young Investigator Medal, 2012
- Materials Research Society Outstanding Young Investigator Award, 2012
- Alfred Noble Prize, 2012 (given by the combined engineering societies of the United States)
- Thomas J.R. Hughes Young Investigator Award (ASME), 2011
- Leonardo da Vinci Award (ASCE Engineering Mechanics Institute), 2011
- Stephen Brunauer Award, 2011 (ACS)
- Rossiter W. Raymond Memorial Award, 2011 (AIME)
- Sia Nemat-Nasser Award (ASME), 2010
- Harold E. Edgerton Faculty Achievement Award, 2010
- Chair, Fourth International Conference on the Mechanics of Biomaterials and Tissues (2010-2011)
- Presidential Early Career Award for Scientists and Engineers (PECASE), 2009
- United States Navy Young Investigator Award, 2008
- Participant and Plenary Speaker, National Academy of Engineering Frontiers of Engineering Symposium (recognized as one of the top engineers in the country between the ages of 30-45; 2007, 2008)
- DARPA Young Faculty Award, 2008
- Air Force Young Investigator Award, 2008
- Esther and Harold E. Edgerton Career Development Chair Professorship, 2007
- National Science Foundation CAREER Award, 2007
- Poster Award, International Conference on Mechanics of Biomaterials and Tissues, 2005
- First Prize Gold Graduate Student Award, Materials Research Society, 2004

### Selected Publications

1. T. Knowles, M.J. Buehler, " Nanomechanics of functional and pathological amyloid materials," *Nature Nanotechnology*, Vol. 6 (7), pp. 469-479, 2011

2. S. Keten, M.J. Buehler, "Nanostructure and molecular mechanics of dragline spider silk protein assemblies," *Journal of the Royal Society Interface*, Vol. 7(53), pp. 1709-1721, 2010 (paper highlighted in *Science*)
3. S. Keten, Z. Xu, B. Ihle, M.J. Buehler, "Nanoconfinement controls stiffness, strength and mechanical toughness of beta-sheet crystals in silk," *Nature Materials*, Vol. 9, pp. 359-367, 2010
4. S. Cranford, M.J. Buehler, "Materiomics: Biological Protein Materials, from Nano to Macro," *Nanotechnology, Science and Application*, Vol. 3, pp. 127-148, 2010
5. Z. Qin, M.J. Buehler, "Molecular Dynamics Simulation of the  $\alpha$ -Helix to  $\beta$ -Sheet Transition in Coiled Protein Filaments: Evidence for a Critical Filament Length Scale," *Physical Review Letters*, Vol. 104(19), paper # 198304, 2010
6. D. Sen, K. Novoselov, P. Reis and M.J. Buehler, "Tearing of graphene sheets from adhesive substrates produces tapered nanoribbons," *Small*, Vol. 6(10), pp. 1108-1116, 2010
7. M.J. Buehler, "Strength in numbers", *Nature Nanotechnology*, Vol. 5, pp. 172-174, 2010
8. M.J. Buehler, Z. Xu, "Materials science: Mind the helical crack," *Nature*, Vol. 464(4), pp. 42-43, 2010
9. Y.C. Yung, J. Chae, M.J. Buehler, C. Hunter, D. Mooney, "Cyclic tensile strain triggers a sequence of autocrine and paracrine signaling that regulate angiogenesis in human vascular cells," *P. Natl. Acad. Sci. USA*, Vol. 106, pp. 15279-15284, 2009
10. S. Uzel, M.J. Buehler, "Nanomechanical sequencing of tropocollagen molecules," *Integrative Biology*, Vol 1(7), pp. 452-459, 2009
11. T. Ackbarow, D. Sen, C. Thaulow, M.J. Buehler, "Alpha-Helical Protein Networks are Self Protective and Flaw Tolerant," *PLoS ONE*, Vol. 4(6), paper # e6015, 2009
12. M.J. Buehler, Y. Yung, "Deformation and failure of protein materials in extreme conditions and disease," *Nature Materials*, Vol. 8(3), pp. 175-188, 2009
13. S. Keten and M.J. Buehler, "The strength limit of entropic elasticity in beta-sheet protein domains," *Physical Review E*, Vol. 78(6), paper number 061913, 2008.
14. M.J. Buehler, S. Keten, T. Ackbarow, "Theoretical and computational hierarchical nanomechanics of protein materials: Deformation and fracture," *Progress in Materials Science*, Vol. 53(8), pp. 1101-1241, 2008.
15. S. Keten and M.J. Buehler, " Geometric Confinement Governs the Rupture Strength of H-bond Assemblies at a Critical Length Scale," *Nano Letters*, Vol. 8(2), 2008.
16. T. Ackbarow, X. Chen, S. Keten, M.J. Buehler, " Hierarchies, multiple energy barriers and robustness govern the fracture mechanics of alpha-helical and beta-sheet protein domains" , *P. Natl. Acad. Sci. USA*, Vol. 104(42), pp. 16410-16415, 2007 (cover article)
17. M.J. Buehler, H. Tang, A. C.T. van Duin, W.A. Goddard III, " Threshold Crack Speed Controls Dynamical Fracture of Silicon Single Crystals," *Physical Review Letters*, Vol. 99, p. 165502, 2007
18. M.J. Buehler and T. Ackbarow, " Fracture mechanics of protein materials," *Materials Today*, Vol. 10(9), pp. 46-58, 2007 (cover article)
19. M.J. Buehler and S.Y. Wong, "Entropic elasticity controls nanomechanics of single tropocollagen molecules," *Biophys. J.*, Vol.

93(1), pp. 37-43, 2007

20. M.J. Buehler, "Defining nascent bone by the molecular nanomechanics of mineralized collagen fibrils," *Nanotechnology*, Vol. 18, 295102, 2007

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