Woo Kyun Kim

Assistant Professor
Department of Mechanical and Materials Engineering
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EDUCATION

The University of Michigan	Mechanical Engineering	Ph.D.	2009
Seoul National University, Korea	Mechanical Design&Production Eng.	M.S.	1999
Seoul National University, Korea	Mechanical Design&Production Eng.	B.S.(summa cum laude)	1997

ACADEMIC EXPERIENCE

2014-Present Assistant Professor, Mechanical and Materials Engineering, The University of Cincinnati
2013-2013 Research Associate, Aerospace Engineering & Mechanics, The University of Minnesota (Advisor: Professor Ellad B. Tadmor)
2010-2013 Postdoctoral Associate, Aerospace Engineering & Mechanics, The University of Minnesota (Advisor: Professor Ellad B. Tadmor)
2009-2010 Postdoctoral Associate, Materials Science & Engineering, Johns Hopkins University (Advisor: Professor Michael L. Falk)
2005-2009 Research Assistant, Materials Science & Engineering, The University of Michigan (Advisor: Professor Michael L. Falk)
1997-1999 Researcher, Mechanical Design and Production Engineering, Seoul National University, Korea (Advisor: Professor Soo-Ik Oh)
1997 Teaching Assistant, Mechanical Design and Production Engineering, Seoul National University, Korea

INDUSTRIAL EXPERIENCE

1999-2004, Research Engineer, Gasoline Engine Design Team, Central R&D Center, Hyundai Motor Company, Korea

HONORS AND AWARDS

2010, Second-place Poster Prize, The Gordon Conference on Tribology
2007, Alexander Azarkhin Scholarship (awarded to one exceptional graduate student each year), The University of Michigan
2006, Second-place Poster Award, COE Graduate Student Symposium, The University of Michigan
1997-1999, Scholarship of Industrial & Academic Cooperative Program, Hyundai Motor Company, Korea
1996, Honor Student with Scholarship, Seoul National University, Korea
1995, Honor Student with Scholarship, Seoul National University, Korea

SELECTED PUBLICATIONS

[1] H. J. Kim, **W. K. Kim**, M. L. Falk, and D. A. Rigney, "MD simulations of microstructure evolution during high-velocity sliding between crystalline materials," Tribol. Lett., 28, 299, 2007.

[2] **W. K. Kim** and M. L. Falk, "Accelerated molecular dynamics simulation of AFM experiments using the bond-boost method," Mater. Res. Soc. Symp. Proc., 1085, 2008.

[3] H. -J. Kim, A. Emge, R. E. Winter, P. T. Keightley, **W. -K. Kim**, M. L. Falk, and D. A. Rigney, "Nanostructures generated by explosively driven friction: experiments and molecular dynamics simulations," Acta Mater., 57, 5270, 2009.

[4] **W. K. Kim** and M. L. Falk, "Atomic-scale simulations on the sliding of incommensurate surfaces: The breakdown of superlubricity," Phys. Rev. B, 80, 235428, 2009.

[5] **W. K. Kim** and M. L. Falk, "Accelerated molecular dynamics simulation of low-velocity frictional sliding," Model. Simul. Mater. Sci. Eng., 18, 034003, 2010.

[6] **W. K. Kim** and M. L. Falk, "Role of intermediate states in low-velocity friction between amorphous surfaces," Phys. Rev. B, 84, 165422, 2011.

[7] **W. K. Kim** and E. B. Tadmor, "An analytical self-consistent solution for the free energy of a 1-D chain of atoms including anharmonic effects," J. Stat. Phys., 148, 951-971, 2012.

[8] E. B. Tadmor, F. Legoll, **W. K. Kim,** L. M. Dupuy, and R. E. Miller, "Finite-temperature quasicontinuum," Appl. Mech. Rev., 65, 010803, 2013.

[9] **W. K. Kim,** M. Luskin, D. Perez, A. F. Voter, and E. B. Tadmor, "Hyper-QC: An accelerated finite-temperature quasicontinuum method using hyperdynamics," J. Mech. Phys. Solids, 63, 94-112,2014.

[10] **W. K. Kim** and M. L. Falk, "A practical perspective on the implementation of hyperdynamics for accelerated simulation," J. Chem. Phys, 140, 044107, 2014.

[11] **W. K. Kim** and E. B. Tadmor, "Entropically stabilized dislocations," Phys. Rev. Lett., 112, 105501, 2014.

ORAL PRESENTATIONS

2014 Mach Conference (invited), Annapolis, MD, "Nanoindentation Simulation Using Hyper-QC."

2013 Solid and Continuum Mechanics Research Seminar, Aerospace Engineering & Mechanics, The University of Minnesota, "An Accelerated Finite-Temperature Quasicontinuum Method Using Hyperdynamics."

2011 48th SES Conference, Evanston, IL, "Accelerated Finite-Temperature Quasicontinuum Simulations Using Hyperdynamics."

2011 11th USNCCM Meeting, Minneapolis, MN, "Accelerated Finite-Temperature Quasicontinuum Simulations Using Hyperdynamics."

2009 MRS Fall Meeting, Boston, MA, "Accelerated Molecular Dynamics Simulations of Atomic-Scale Friction on Amorphous Silica Surfaces: Temperature and Sliding Velocity dependence."

2009 APS March Meeting, Pittsburg, PA, "Molecular Dynamics Simulations on Friction of Incommensurate Interfaces."

2008 MRS Spring Meeting, San Francisco, CA, "Accelerated Molecular Dynamics Studies of AFM Experiments using Hyper Dynamics."

2008 APS March Meeting, New Orleans, LA, "Accelerated Molecular Dynamics Studies of AFM Experiments using Hyper Dynamics."

2007 APS March Meeting, Denver, CO, "Molecular Dynamics Studies of Friction between Bare and Oxidized Silicon."

MENTORING STUDENTS

[1] Yuchong Shao (MSE, Johns Hopkins Universuty): project on using molecular dynamics simulation and modeling to study wear mechanisms of a single-asperity dry contact at atomistic level.
[2] Subrahmanyam Pattamatta (AEM, U. Minnesota): project on developing a rate-dependent driven dynamics method based on a branch-following and bifurcation generated equilibrium map.

PROFESSIONAL SERVICE ACTIVITIES

[1] Served as the liaison for high-performance computing (Minnesota Supercomputing Institute, U. Minnesota) and the Titan parallel supercomputer (AEM, U. Minnesota) for Prof. Tadmor's research group
[2] Provided some feedback to the review of a JMPS paper

COLLABORATORS (PAST 5 YEARS)

Laurent Dupuy (CEA, France), Michael Falk (Johns Hopkins University), Frederic Legoll (Université Paris-Est, France), Mitchell Luskin (U. Minnesota), Ronald Miller (Carleton, Canada), Danny Perez (LANL), Ellad Tadmor (U. Minnesota), Arthur Voter (LANL)

PATENTS

[1] A gasket mounting structure of engine head cover (Registration Number: 10-0401849, Korea)
[2] Engine oil circulation equipment with belly oil tank (Registration Number: 10-0507222, Korea)

RESEARCH INTERESTS

My broad research area is the atomistic modeling and computer simulation of materials systems. I am particularly interested in the development of multiscale methods to span both length and time scales. Most conventional fully-atomistic methods like molecular dynamics (MD) suffer from the great difference in length and time scales between the atomic-scale processes comprising the materials system and the macroscopic real-life processes, and the multiscale methods are the attempts to bridge this gap. In particular, to increase the time scales accessible to conventional MD simulation, which are limited to sub-microseconds, I have used hyperdynamics. My current interest in this direction is to devise a novel bias potential for the hyperdynamics simulation that is both computationally inexpensive and robust. In spatial multiscale modeling, I have used the quasicontinuum (QC) method. In particular I have developed "hyper-QC" that can simultaneously span both length and time scales by combining hyperdynamics and QC. Hyper-QC enables to simulate larger systems for longer durations than fully-atomistic unaccelerated models and hence has the broadest impact on any sub-filed of materials modeling. Among many potential applications, I am particularly interested in simulating atomic force microscope (AFM) experiments to study atomic-scale friction. Atomic-scale friction exhibits very different characteristics from that in macroscopic systems and has been widely investigated as nanotechnology advances. Especially preventing wear and adhesion is one of the most critical issues in the performance and fabrication of micro/nano-electromechanical systems (MEMS/NEMS) devices. Friction and wear of biomaterials are

also investigated using AFM. My current goal in this direction is to simulate realistic AFM models under experimental conditions using the hyper-QC method.