

**Mark KACHANOV**

Professor of Mechanical Engineering  
Tufts University  
Medford, MA 02155

*Tel* (617) 627-3318    *Email:* mark.kachanov@tufts.edu    *Website:* <http://www.tufts.edu/~mkachano/>

**Highest degree earned**

1981                      Ph.D. in Solid and Structural Mechanics  
Brown University

**Research interests:**

- Micromechanics and conductivity of heterogeneous materials; Microstructure-property relations; Applications to plasma-sprayed and PVD coatings, composites and geo-materials
- Rough surfaces: mechanical properties and conductivity in relation to microstructure
- Nanoelectromechanics of piezoelectric indentation; Applications to scanning probe microscopy

**Appointments**

1988-present              Professor of Mechanical Engineering  
Tufts University

1983-1988                 Associate Professor of Mechanical Engineering  
Tufts University

1980-1983                 Assistant Professor of Mechanics and Materials Science  
Rutgers University

**Visiting appointments**

1999, 2003, 2006        Ecole Normale Superieure (France)

1996-1998                 von Humboldt Professor, Darmstadt Polytechnic Institute (Germany)

1992                         MTS Visiting Professor, University of Minnesota

1983                         Visiting Scientist, NIST

**Seminars and invited lectures (from 2000)**

U of Connecticut (2000); U of Hannover, Germany (2000); NIST (2000), Siemens Research Center, Germany (2000), Caterpillar Co (2000), Summer school on physical aspects of fracture, NATO Advanced Study Institute, France (2000), Northwestern U (2001), ALSTOM Industries, Switzerland (2001), Merck Research Center, Germany (2001), Louisiana State U, distinguished lecture series (2001), Harvard U (2001), Stanford U (2002), U of California-Berkeley (2002), New Mexico State U (2002), Sandia National Lab (2002), General Motors (2003), United Technologies Research Center (2003), U of Paris-6, France (2003), Free U of Berlin, Germany (2003), US Army Research Center (2004), Ecole Normale Supérieure, France (2003, 2006), General Electric (2005), U of Toronto, Canada (2005), U of Waterloo, Canada (2005), U of Cyprus (2006), Worcester Polytechnic Institute (2006), Madrid Polytechnic Institute, Spain (2006), Schlumberger (2006), U of Tampere, Finland (2007), Oak Ridge National Lab (2007), Institute of Fundamental Problems of Mechanics, Russian Academy of Sciences, Moscow (2007).

**Research grants, Principal Investigator (total: 2.3 mln)**

"Elastic Interactions of a Crack with Damage and Associated Energy Release Rates," awarded in 1984 by the Air Force Office of Scientific Research (\$72,050)

"Stress Analysis in Elastic Solids with Many Cracks," awarded in 1984 by the Army Research Office (\$60,365)

"Stress Analysis in Elastic Solids with Many Cracks, Additional Topics," awarded in 1986 by the Army Research Office (\$40,400)

"Effective Elastic Properties of Cracked Solids," awarded in 1986 by the U.S. Department of Energy (\$107,000).

"Stress Analysis in Solids with Multiple Inhomogeneities," awarded in 1988 by the Army Research Office (\$202,490)

"Effective Elasticity of Heterogeneous Materials," awarded in 1988 by DOE (\$180,000).

"Microcrack Interactions in Brittle Materials," awarded in 1989 by ALCOA (\$7,500)

"Modeling of Multiple Site Damage in Aircraft," awarded in 1989 by the U.S. Department of Transportation (\$20,000)

"Fracture of Brittle Materials under Compression", awarded in 1992 by the U.S. Department of Energy (\$190,000).

"Localization of Deformation in Brittle Materials", awarded in 1992 by the Air Force Office of Scientific Research (\$182,000).

"Mechanics of Anisotropic Materials with Damage", awarded in 1995 by the Army Research Office (\$217,000).

"Heat Conduction in Ceramic Coatings", awarded in 1996 by NASA (\$79,374).

"Micromechanics of Materials with Defects of Various Shapes", awarded by National Science Foundation in 1997 (\$127,000).

"Crack Dynamics in Ice", jointly with Dartmouth College, awarded by National Science Foundation in 1997. Tufts University part of the award: \$ 127, 400

"Microstructure and Thermal Conductivity of Ceramic Coatings ", awarded in 1997 by NASA (\$185,783)

"Solids with Cracks and Pores of Various Shapes: Extraction of Information on Damage from Wavespeed Patterns", awarded by U.S.Dept of Energy in 1997 (\$190,050)

"Plasma-Sprayed Ceramic Coatings: Conductivity and Elasticity in Relation to the Microstructure", awarded by General Electric in 2000 (\$20,000)

"Thermal Barrier Coatings: Microstructure to Life", awarded by ALSTOM Industries in 2001 (\$37,500)

"Statistical Crack Mechanics and Porosity Modeling", awarded by Sandia National Lab in 2003 (\$60,000)

"Macroscopic stress-strain relations with microcrack induced inelasticity", awarded by Sandia National Lab in 2004 (\$55,000)

"Nanoelectromechanics of Piezoelectric Indentation and Applications to Scanning Probe Microscopies", awarded by National Science Foundation in 2005 (\$180, 300).

**Consulting history:** NIST, Shell, SRI International, GE, Axcelis, GTE, Schlumberger, Alstom Power (Switzerland)

### **Miscellaneous**

- Editor-in-Chief, *International Journal of Engineering Sciences*
- Editor, *Letters in Fracture and Micromechanics*
- von Humboldt Research Award for Senior Scientists (Germany)
- Five of recent students/postdocs won faculty positions at US Universities

- Science Citation Index: 2,600

**PUBLICATIONS: Total number: 130**

**Books**

"**Micromechanics of Materials**": Contract with *Cambridge University Press*, work in progress

"**Handbook of Elasticity Solutions**", with B.Shafiro and I.Tsukrov, *Kluwer Academic Publishers*, 2003

**Book Chapters and Invited Reviews**

Effective Elastic properties of Cracked Solids, *Applied Mechanics Reviews*, **45**(8), 305-336, 1992

Elastic Solids with Many Cracks and Related Problems, pp. 256-426, in "*Advances in Applied Mechanics*", 1994

Effective Properties of Solids with Cavities of Various Shapes, with I.Tsukrov and B.Shafiro, *Applied Mechanics Reviews*, **47**(1), pp. 151-174, 1994

Mechanics of Anisotropic Materials with Multiple Cracks, with C.Mauge, pp. 3-46, in "*Key Engineering Materials*", 1996

*Tutorial*: "Effective elasticity of fractured rocks", with V.Grechka, *Geophysics*, **71** (6) pp. W45-W58, 2006

Connections between elastic and conductive properties of heterogeneous materials, with I.Sevostianov, in "*Advances in Applied Mechanics*", pp. 69-255, 2008

Effective Properties of Porous and Microcracked Rocks, with Y. Gueguen, in "*Microstructure and Properties of Rocks*", Springer (in press)

**Journal Articles: Last ten years**

"Green's Functions for a Transversely Isotropic Space containing a Circular Crack", with E.Karapetian, *Acta Mechanica*, **126**, 169-187, 1998

"Solids with Non-Spherical Cavities: Cavity Compliances and the Overall Anisotropy", with B. Shafiro, *Journal of the Mechanics and Physics of Solids*, **46**(2), 1-21, 1998

"Microfracturing Patterns and Effective Elastic Properties of Solids with Interacting Holes", with I. Tsukrov, *Computer Methods in Composite Materials*, **6**, 341-350, 1998

"On the Stress Intensity Factor for the Elliptical Crack", with B.Nuller and E.Karapetian, International Journal of Fracture, **92** (2), L17-20, 1998

"On Calculation of SIFs for Circular and Moderately Non-Circular Cracks", with E.Karapetian, International Journal of Fracture, **92** (2), L21-26, 1998

"Anisotropic Material with Arbitrarily Oriented Cracks and Elliptical Holes: Effective Elastic Properties" with I.Tsukrov, International Journal of Fracture **92**(1), L3-8, 1998

"Microstructure of the Cortical Bones and Their Effective Elastic Properties", with I.Sevostianov, International Journal of Fracture, **92**, L9-14, 1998

"Compliance Tensors of Ellipsoidal Inclusions", with I.Sevostianov, International Journal of Fracture, **96**, L3-7, 1999

"Solids with Cracks and Non-Spherical Cavities: Proper Parameters of Defect Density and Effective Elastic Properties", International Journal of Fracture, **97**, 1-32, 1999

"Point Force and Point Electric Charge in Piezoelectric Transversely Isotropic Solids", with E.Karapetian and I.Sevostianov, Philosophical Magazine-B, **80** (3), 331-359, 2000.

"Modeling of the Anisotropic Elastic Properties of Plasma-Sprayed Coatings in Relation to Their Microstructure", with I.Sevostianov, Acta Materialia, **48**(6), 1361-1370, 2000

"Penny-Shaped and Half-Plane Cracks in the Piezoelectric Transversely Isotropic Solid, with E.Karapetian and I.Sevostianov, Archive of Applied Mechanics, **70** (1-3), 201-229, 2000.

"Construction of the Displacement and Stress Fields in a Plane with Multiple Cracks", with L.Gorbatikh, Engineering Fracture Mechanics, **60**, 53-65, 2000

"Impact of the porous microstructure on the overall elastic properties of the osteonal cortical bone" with I.Sevostianov, Journal of Biomechanics, **33** (7), 881-888, 2000

"Effective Moduli of an Anisotropic Material with Elliptical Holes of Arbitrary Orientational Distribution", with I.Tsukrov, International Journal of Solids and Structures **37**, 5919-5941, 2000

"Microcracking in Piezoelectrics Reduces the Electromechanical Coupling and Alters Its Directionality", with I.Sevostianov, International Journal of Fracture, **101**, L3-8, 2000

"Anisotropic Effective Conductivity of Materials with Non-Randomly Oriented Inclusions of Diverse Ellipsoidal Shapes", with B.Shafiro, Journal of Applied Physics, **87**, pp.8561-8569, 2000

"Explicit Cross-Property Correlations for Anisotropic Porous Microstructures", with I.Sevostianov & B.Shafiro, Journal of the Mechanics and Physics of Solids, **49**, 1-25, 2001

"Thermal Conductivity of Plasma Sprayed Coatings in Relation to Their Microstructure", with I.Sevostianov, Journal of Thermal Spray Technology, **9**(4), pp.478-482, 2001.

"Plasma-Sprayed Ceramic Coatings: Anisotropic Elastic and Conductive Properties in Relation to the Microstructure; Cross-Property Correlations", with I.Sevostianov, Materials Science and Engineering-A, **297**, 235-243, 2001

"On the Yield Condition for Anisotropic Porous Materials", with I.Sevostianov, Materials Science and Engineering-A, **313**, 1-15, 2001

Letter to Editor, with I.Sevostianov, Journal of Biomechanics, **24**, 709-710, 2001

"Sliding on Cracks with Non-Uniform Frictional Characteristics", with B.Nuller and L.Gorbatikh, International Journal of Solids and Structures, **42/43**, 7501-7524, 2001

"Elastic compliance of an annular crack", with I.Sevostianov, International Journal of Fracture, **110**, L31-34, 2001

"Recovery of Information on Microstructure of Porous / Microcracked Materials from the Effective Elastic / Conductive Properties, with L.Gorbatikh and I.Sevostianov, Materials Science and Engineering, **A-318**, 1-14, 2001.

"Piezocomposites: effective piezoelectric constants and design with the prescribed overall properties", with I.Sevostianov, Archive of Applied Mechanics, **71**, 733-747, 2001.

"Explicit Cross-Property Correlations for Anisotropic Two-Phase Composite Materials", with I.Sevostianov, Journal of the Mechanics and Physics of Solids, **50**, 253-283, 2002

"Non-Uniform Frictional Sliding on Cracks under Cyclic Loading", with B.Nuller and L.Gorbatikh, International Journal of Solids and Structures, **39**, 89-104, 2002

"Cross-property correlations for short fiber reinforced composites with damage and their experimental verification", with V.Verijenko and I Sevostianov, Composites-B **33**,205-213, 2002

"On the elastic properties of PVD coatings in relation to their microstructure", with J.Ruud and I. Sevostianov, Materials Science and Technology, **124**, pp.246-250, 2002

"On the Perfectly Plastic Flow in Porous Material", with T.Zohdi and I.Sevostianov, International Journal of Plasticity, **18**, 1649-1659, 2002

"A Principle of Correspondence for the Piezoelectric Solids", with E.Karapetian and I.Sevostianov, Archive of Applied Mechanics, **72**, 564-587, 2002

"On the Elastic Compliances of Irregularly Shaped Cracks", with I.Sevostianov, International Journal of Fracture, **114**, 245-257, 2002

“Correlations between Elastic Moduli and Thermal Conductivities of Anisotropic Short Fiber Reinforced Thermoplastics: Theory and Experimental Verification”, with I.Sevostianov, Materials Science and Engineering -A, **360**, 339-344, 2003

“On the Problems of Crack Interactions and Crack Coalescence”, International Journal of Fracture **120**(3), 537-543, 2003

“On Elastic-Conductive Cross-Property Correlations for Granular Materials”, Proc. Royal Society-A, **460**, 1529-1534, 2004.

“Quantitative Characterization of Microstructures of Plasma-Sprayed Coatings and Their Conductive and Elastic Properties”, with I.Sevostianov and J.Ruud, Materials Science and Engineering-A, **386**, 164-174, 2004

“Quantitative Characterization of Microstructures of Plasma-Sprayed Coatings and Their Conductive and Elastic Properties, with I.Sevostianov and J. Ruud, P. Lorraine and M. Dubois, Materials Science and Engineering-A, **386**, 164-174, 2004.

“Nanoelectromechanics of Piezoresponse Force Microscopy”, with S.Kalinin and E. Karapetian, Physical Reviews-B, **70**, 184101-181124, 2004

“On Quantitative Characterization of Microstructures and Effective properties”, with I.Sevostianov, International Journal of Solids and Structures **42**, 309-336, 2005

“A Note on Micromechanics of Plastic Yield in Porous Solids”, with T.Zohdi, International Journal of Fracture, **133**, 31-35, 2005

“Simultaneous Elastic and Electromechanical Imaging by Scanning Probe Microscopy”, with S.Kalinin and E. Karapetian, Journal of Vacuum Science and Technology-B, **23**, 2102-2108, 2005

“Nanoelectromechanics of Piezoelectric Indentation and Applications to Scanning Probe Microscopies of Ferroelectric Materials”, with S.Kalinin and E. Karapetian, Philosophical Magazine, **85** (10), 1017-1951, 2005

“Nanoelectromechanics of Polarization Switching in Piezoresponse Force Microscopy”, Journal of Applied Physics, **97**, 074305-074311, 2005

“Plastic Yield Surfaces of Anisotropic Porous Materials in Terms of Effective Electric Conductivities”, with I.Sevostianov, Mechanics of Materials, **38**, 908-923, 2006

“Effective Elasticity of Fractured Rocks: A Snapshot of Work in Progress”, a Tutorial, with V.Grechka, Geophysics, **71**, W45-58, 2006.

“Homogenization of a Nano-particle with Graded Interface”, International Journal of Fracture, **139**, 121-127, 2006

“Seismic Characterization of Multiple Fractures: Does Orthotropy Suffice?” with V.Grechka, Geophysics, **71** (3), D93-D105, 2006

“Effective Elasticity of Fractured Rocks”, with V.Grechka, The Leading Edge, 152-156, 2006

“Effective Elasticity of Rocks with Closely Spaced and Intersecting Fractures”, with V.Grechka, Geophysics, **71** (3), D85-D91, 2006

“The Influence of Crack Shapes on the Effective Elasticity of Fractured Rocks”, with V.Grechka, Geophysics, **71** (5), D153-D160, 2006

“Elastic Compliances of Non-Flat Cracks”, with M. Mear and I. Sevostianov, International Journal of Solids and Structures, **44**, 6412-6427, 2007

“Indentation of Punches into Piezoelectric Half-Space with Frictional Sliding: Applications to Scanning Probe Microscopy”, with A.Makagon, E.Karapetian and S. Kalinin, Physical Review-B, **76**, 064115-064129, 2007

“Relations between compliances of inhomogeneities having the same shape but different elastic constants”, International Journal of Engineering Sciences, **45**, 797-806, 2007.

“Effect of interphase layers on the overall elastic and conductive properties of matrix composites. Applications to nano-size inclusions”, International Journal of Solids and Structures, **44**, 1304-1315, 2007

“Contacting rough surfaces: Hertzian contacts vs welded areas”, with I. Sevostianov, International Journal of Fracture, **145**, 223-228, 2007

“Explicit elasticity-conductivity connections for materials with anisotropic inhomogeneities”, with I. Sevostianov, Journal of the Mechanics and Physics of Solids”, with I. Sevostianov, **55**, 2181-2205, 2007

“On the effective elastic properties of cracked solid”, International Journal of Fracture, **146**, 295-299, 2007

“Contact of rough surfaces: a simple model for elasticity, conductivity and cross-property connections”, with I. Sevostianov, Journal of the Mechanics and Physics of Solids, **56**, 1380-1400, 2008.

“On the concept of approximate elastic symmetries and elliptic orthotropy”, International Journal of Engineering Sciences, with I. Sevostianov, **46**, 211-233, 2008

“Normal and tangential compliances of interface of rough surfaces with contacts of elliptical shape”, International Journal of Solids and Structures, with I. Sevostianov, **45**, 2723-2736, 2008

“On computation of the compliance and stiffness contribution tensors of non-ellipsoidal inhomogeneities, with T.Zohdi and I.Sevostianov, International Journal of Solids and Structures, with I. Sevostianov, **45**, 4375-4383, 2008