

# Curriculum Vitae - MACIEJ S. KUMOSA

August 2019

## Research Interests

- Physical Properties, Life Prediction, and Manufacturing of Advanced Materials and Structures for Extreme Applications including High Voltage (HV), High Temperature (HT), High Strain (HS), combined HVTS and others
- Multiscale Modeling of HVT Materials and Structures
- Structural Integrity of HV Non-ceramic Composite Insulator, Polymer Based Composite Transmission Conductors and other HV, HT and HVT Advanced Transmission Structures

## Teaching Interests

Introductory/Advanced Composite Materials, General Materials Science, Nanotechnology for Engineers, Mechanics of Materials, Finite Element Method, Machine Design, Fracture Mechanics, Mechanical Behavior of Solids, Stress Analysis of Structures, and others

## Education

- BS/MS and Ph.D., Applied Mechanics and Materials Science, Tech. University of Wroclaw, 1978 and 1982, Poland.

## Current Employment

- John Evans Professor of the University of Denver, Department of Mechanical and Materials Engineering, University of Denver, 2390 South York Street, Denver, Colorado 80208, tel: (303) 871-3807, fax: (303) 871-4450; mkumosa@du.edu
- National Science Foundation Industry/University Cooperative Research Center for Novel High Voltage/High Temperature Materials and Structures, Overall Center Director ([www.HVTCenter.org](http://www.HVTCenter.org)); one of 50 IUCRC in Engineering in the U.S. in 2016/17

## Academic Honors

- Editorial Board member of
  - *Composites Science and Technology* (#1 int. journal in composites)
  - *Structural Durability & Health Monitoring*
  - *Fibers*

## Awards

- John Evans Professor, the highest recognition at the University of Denver (DU) for outstanding research or other creative, scholarly achievement, April, 2006.  
<http://www.du.edu/news/06-19-06facultyawards.html>
- Best Scholar Award of the School of Eng. and Computer Science, DU, December 2004.
- Distinguished Teaching Award, Oregon Graduate Institute (OGI), Portland, OR, 92-93

## General Interests

Gardening, Bicycling, Mountain living in Cuchara, Investment, Piano, Fly Fishing, World History and Politics, and several others

## Previous Positions

- August 1981 - August 1983  
Senior Research Assistant  
Institute of Materials Science and Applied Mechanics, Technical University of Wrocław  
Wrocław, Wyb. Wyspińskiego 27, Poland
- January 1981 - March 1981  
Visiting Scientist  
Department of Materials Science and Engineering, University of California - Los Angeles
- August 1983 - January 1985  
Assistant Professor  
Department of Materials Science and Applied Mechanics, Technical University of Wrocław, Wrocław, Wyb. Wyspińskiego 27, Poland
- January 1984 - December 1984  
Visiting Research Fellow  
Department of Materials Science and Engineering, University of Liverpool  
Liverpool, England
- December 1984 - March 1990  
Senior Research Associate  
Department of Materials Science and Metallurgy, University of Cambridge  
Cambridge, UK
- October 15 - November 15, 1994  
Visiting Professor  
Department of Mechanical Engineering, University of Paderborn  
Paderborn 33095, Germany
- May 1, 1990 - September 1, 1998  
Associate Professor  
Department of Materials Science and Engineering and Department of Electrical Engineering and Applied Physics, OGI, Portland, Oregon.
- April 1996 – September 1997, Research Professor  
September 1997- September 1999, Associate Professor  
September 1999-present, Full Professor with tenure, since 2006, John Evans Professor  
Department of Engineering, University of Denver  
Denver, Colorado
- Between April 1996 and September 1998 Dr. Kumosa had a dual appointment both at DU and OGI.
- September 15, 2006 - September 14, 2009  
Guest Professor of Harbin Engineering University, Harbin, China

## Administrative Duties

1. **Chair**, Mechanical and Materials Engineering (MME) Department at DU, between September 1, 2007- November 1, 2009; first Chair, built the department, stepped down in 2009 to concentrate on research and to manage the Center for Nanoscale Science and Engineering (see below).
2. **Director**, Center for Advanced Materials and Structures, between 1996 and 2007, built the Center jointly with Drs. P. Predecki and S. Carpenter, internationally recognized through composite research for NSF, AFOSR, EPRI, NASA, DoE and several major US industries.
3. **Director**, Center for Nanoscale Science and Engineering, 2007-2012, built the "Nano-Center" involving seven DU departments/units engaging appr. 25 faculty. Elected in 2007 for two years, unanimously re-elected in 2009 for two more years.
4. **Overall Center Director**, since March 2014 for five years, National Science Foundation Industry/University Cooperative Research Center for Novel High Voltage/High Temperature Materials and Structures, also called the "HVT Center".

The Center includes the University of Denver (leading site), Michigan Technological University, the University of Illinois at Urbana-Champaign, and the University of Connecticut (added in Feb 2017) and 19 supporting major US industries since its inception.

**To learn more about the HVT Center, please see Current and Pending Support and Biographical Sketch.**

## Graduate Student Advising

### Ph.D. Graduate Students

1. Jun Ding, Structure Property Relationship of Advanced High-Temperature Materials, Ph.D., October 1994, OGI (hired after graduation by Intel Corporation, Hillsboro, OR).
2. Shiliang Ding, Mixed Mode Failure Analysis of Adhesively Bonded Composite Systems using the Modified Iosipescu Test Method, Ph.D., March 1995, OGI (hired after graduation by Bradcom, San Diego, CA)
3. Qiong Qiu, Brittle Fracture Mechanisms of Glass-Fiber Reinforced Polymer Insulators, Ph.D., September 1995, OGI (hired by Komatsu Silicon America, Hillsboro, OR).
4. Anurag Bansal, Finite Element Simulation and Mechanical Characterization of Composite Insulators, Ph.D., November 1995, OGI (hired by Altera Corporation, presently senior manager at Applied Materials).
5. Gregory M. Odegard, Shear-Dominated Biaxial Failure Analysis of Polymer-Matrix Composites at Room and Elevated Temperatures, Ph.D., Department of Engineering, University of Denver, June 2000 (hired by NASA Langley)
6. Kevin Searles, The Elastic and Inelastic Behavior of Woven Graphite Fabric Reinforced Polyimide Composites, Ph.D., OGI, October 2000 (hired by Exxon-Mobile Corporation – Upstream Research, Kingwood, TX).

7. Bart Benedikt, Analysis of Residual Stresses in Graphite Fiber/PMR-15 Composites, Ph.D., May 2003 (hired by Los Alamos National Laboratory, Los Alamos, NM).
8. Mark Gentz, Mechanical Response of Graphite/polyimide Composites at Elevated Temperatures, Ph.D., Department of Engineering, University of Denver, August 2004, completed (hired by ATK, Utah).
9. Peter Rupnowski, Multiscale Stress and Damage Initiation Analyses of Graphite Fiber/Polyimide Composites, Ph.D., Department of Engineering, University of Denver, May 2005, completed (hired by NREL, Golden Colorado).
10. Brian Burks, The Effect of Atmospheric Aging on a Hybrid Polymer Matrix Composites' Material Properties, PhD thesis in Mechanical Engineering, Department of Mechanical and Materials Engineering, completed in May 2012 (hired by NIST in Boulder).
11. Zachary Loftus, Electron Beam Direct Manufacturing of Ti-6Al-4V for Space Applications, PhD; University of Denver and Lockheed Martin Corporation, completed in October 2013 (Lockheed Martin Technical Fellow since 2015).
12. James Middleton, Aging of a Polymer Core Composite Conductor under Combined Ozone and Temperature Conditions, PhD in Materials Science, DU, completed in July 2014.
13. Joseph Hoffman, On Thermal Aging Prevention in Polymer Core Composite Conductor Rods, PhD in Nanoscale Science and Engineering, DU, completed in Sept. 2015.
14. Eva Hakansson, Galvanic Corrosion of Aluminum/Carbon Composite Systems, PhD in Mechanical Engineering, DU, completed in June 2016.
15. Monika Bleszynski, Nanoengineering of Next Generation Silicone Rubber Materials for Extreme Applications, PhD in Mat Sci, MME Dept, DU, completed in June 28, 2018.
16. Tianyi Lu, Synergistic Aging of GRP Composites, PhD in Mat Sci, MME Dept., DU, completed in Dec. 2018
17. Chrissy Henderson, Protection of High-Voltage Transformer Bushings and other Brittle Structures Against Impact, PhD in Eng., thesis completed, to be defended in Sep 2019.

#### **Master Graduate Students**

1. Natarajan Sukumar, Finite Element Analysis of Mixed Mode Fracture and Failure in Iosipescu Specimens, MS in Materials Science, Oregon Graduate Institute, October 1992.
2. Ibrahim Erdinc, Singular Stress Fields at Interfaces and Sharp Notches, M.S. in Materials Science, July 1992, Oregon Graduate Institute and University of Paderborn, Germany.
3. Andreas Schubert, Comprehensive Numerical and Experimental Studies of Internal Stresses in Composite (GRP) Substation Insulators, M.S. in Materials Science, October 1994, OGI and University of Paderborn, Germany.
4. M. V. Balakrishnan, Application of the Biaxial Iosipescu Test Fixture for the Mechanical Characterization of Unidirectional Composites, M.S. in Materials Science, September 1995, OGI.

5. Yong Zhao, An Electrical Study of the Brittle Fracture Failure of Composite Insulators, M.S. in Mechanical Engineering, Department of Engineering, University of Denver, November 1997.
6. Yongyu Han, Finite Element Analyses of Advanced Composite Structures, MS in Mechanical Engineering, Department of Engineering, University of Denver, November 1997.
8. Gregory M. Odegard, Biaxial Failure Investigation of Polymer Matrix Composites, M.S. in Mechanical Engineering, Department of Engineering, University of Denver, July 1998.
9. Joe Stowe, Material Property Predictions of Polymers Using Molecular Dynamics Simulations, Ms in ME, MME Dep., DU, completed in May 2008.
10. Brian Burks, Short-Term Failure Analysis of Aluminum Conducting Composite Core Transmission Lines, MS in ME, MME Dep., DU, completed in July 2009.
11. Rebekah Kovarik, An Experimental Study of Optical Adhesive Bonds Subjected to Thermal Cyclic Environments, MME Dep., DU, University of Denver, completed in August 2010.
12. Bruce Allen, New Open Source Software for Building Molecular Dynamics Systems, MS thesis in Materials Science, MME Dep., DU, completed in May 2012.
13. Eva Hakansson, Galvanic Corrosion of High-Temperature Low Sag (HTLS) Conductors: New Materials - New Challenges, MME Dep., DU, completed in May 2013.
14. James Kosak. Stress Corrosion Cracking in Polymer Matrix Glass Fiber Composites. MS Thesis in Mechanical Engineering, MME Dep., DU, completed in May 2014.
15. Tianyi Lv, Degradation of High Voltage Glass Fiber-Reinforced Polymer Matrix Composites by Aggressive Environmental Conditions, MS in Materials Science, Department of Mechanical and Materials Engineering, DU, completed in July 2014.
16. Monika Bleszynski, Aging Assessment of High Voltage Single Component Room Temperature Vulcanized Silicone Rubber (RTV-1) Subjected to Aqueous Salt, MS in Engineering, MME Dep., DU, completed Dec 9, 2015.
17. Daniel Waters, Low-Velocity Impact to High-Temperature Low-Sag Overhead Conductors, MS in Mechanical Engineering, MME Dep., DU, completed in Feb 2016.
18. Edward Clark, Variable Oxidation & Defects in Ti-6Al-4V Material in Electron Beam Melting Additive Manufacturing, MME Dep., DU, completed in March 2017.
19. Robert Woll, Ice Adhesion Analysis of Severely Aged PDMS Rubbers; MS in Materials Science, MME Dept. , DU, completed in June, 2018.

### **Graduate Student Co-Advising**

1. Barnes J. A, Torsion Testing of Filament Wound Composite Cylinders, Ph.D., 1986, University of Cambridge (with D. Hull; M. Kumosa provided full time academic advising).
2. Broughton W. R., Shear Properties of Unidirectional Carbon-Fibre Composites,

- Ph.D., November 1989, University of Cambridge (with D. Hull; M. Kumosa provided full time academic advising).
3. Huang Xue-Ning, Mode I and Mode II Intralaminar Fracture of Unidirectional Composites, Ph.D., October 1990, University of Cambridge (with D. Hull; M. Kumosa provided full time academic advising).
  4. Tom Ely, Depth Profiling Residual Stresses in Thin Tungsten Films Using X-ray Diffraction, Ph.D., August 1999, University of Denver (with P. K. Predecki; M. Kumosa provided part time financial and academic support).
  5. Danut Dragoi, Residual Stress Analysis of Graphite/Polyimide Composites using the Concept of the Metallic Inclusions, Ph.D., June 1999, Department of Engineering, University of Denver (with P.K. Predecki; M. Kumosa provided major financial support and part time academic advising).

## **Most Accomplished Graduate Students Advised by M. Kumosa**

1. **Professor N. Sukumar**, MS at OGI in 1992; presently Professor of Computational Mechanics, University of California, Davis
2. **Dr. A. Bansal**, PhD at OGI in 1995; presently Senior Manager at Applied Materials Inc.
3. **Professor G. Odegard**, PhD at DU in 2000; presently
  - Professor of Computational Mechanics at MTU
  - HVT Site Director at MTU since March 2014
  - Director of the NASA Institute for Ultra-Strong Composites by Computational Design; since August 2017, \$15M grant from NASA for five years
4. **Dr. K. Searles**, PhD at OGI in 2000; presently Senior Research Engineer at Exxon-Mobil Corporation – Upstream Research, Kingwood, TX
5. **Dr. B. Benedikt**, PhD at DU in 2003; presently Senior Scientist at Los Alamos National Laboratory
6. **Dr. P. Rupnowski**, PhD at DU in 2005; presently Senior Scientist at NREL in Golden, CO
7. **Dr. Z. Loftus**, PhD at DU in 2013; presently Lockheed Martin Technical Fellow, Denver Colorado
8. **Dr. B. Burks**, PhD at DU in 2012; presently VP Engineering at Digital Wave Corp., Englewood, CO

## **Current Research Group**

### **PhD and MS Graduate Students**

1. Chrissy Henderson, final year PhD in Engineering, permanent employment at the US Bureau of Reclamation, expected completion in Fall 2019
2. Daniel Waters, third year PhD in Mechanical Engineering, expected completion in 2020

3. Billy Grell, second year PhD in Mechanical Engineering, permanent employment with Lockheed Martin; expected completion in 2020
4. Sabuj Khadka, third year PhD in Mechanical Engineering; expected completion in 2020
5. Edward Clark, second year PhD student in Materials Science
6. Matt Reil, MS in Materials Science, second year
7. Jedi Williams, PhD in Materials Science, first year

### **Postdoctoral Workers**

1. Dr. Joe Hoffman, Research Scientist and Deputy Director of DU HVT Center, since Dec. 2015
2. Dr. Monika Bleszynski, Research Scientist and Program Manager in HVT Center
3. Tianyi Lu, Junior scientist in HVT Center, PhD defended in Feb 2018 without revisions, graduation completed in August 2019.

### **Courses Taught**

- Introduction to Composites (Part I) and Advanced Composites (Part II),
- Introduction to Finite Elements (Part I) and Advanced Finite Elements (Part II)
- Introduction to Nanotechnology for Engineers (Part I) and Advanced Topics in Nanotechnology (Part II)
- Materials Science; Part I and Part II,
- Machine Design, Strength of Materials, Mechanical Behavior of Solids, Mechanics of Materials, etc.

#### Comments:

1. Course evaluations usually higher than department averages; can be provided on request.
2. Several courses were taught outside of DU (for example; Nanotechnology I and II at Lockheed Martin, Fall 2008, Introduction to Composites, Lockheed Martin, Fall 2008, others).

### **Short Courses for Industry**

1. Fracture and Fatigue: Principles and Analysis, M. Kumosa (OGI) with G. Glinka (University of Waterloo) and R. Gordon (EWI), April 10-11, 1991, 16 participants, course evaluation - excellent.
2. Fracture and Fatigue of Advanced Materials, M. Kumosa (OGI) with G. Glinka, S. Hudak (Southwest Research Institute), F.G. Buchholz (Univ. of Paderborn) and R. Stephens (Univ. of Iowa), 15 participants, course evaluation - excellent.
3. Structural Integrity of Composite Structures, M. Kumosa, F. G. Buchholz (University of Paderborn) and M. Kunze, October 25-October 29, 1994, University of Paderborn, Germany 18 participants.

4. Non-Ceramic Insulators; Applications, Design, Testing and Analysis, M. Kumosa, E. Bennett (BPA), J.M. Braun (Ontario Hydro, Canada), T.S. McQuarrie (Glasforms, Inc.), course evaluation - very good, 35 participants (from 9 countries).

## **Invited Lectures, Conference Presentations and Seminars**

Since 1982, Dr. Kumosa has given approximately 400 presentations (including numerous invited lectures) at various academic and industrial institutions in several countries including Poland, United Kingdom, France, Germany, United States of America, Austria, Japan, Singapore, Canada and China.

## **Total Competitive Research Funding between 1990 and Present**

- Total – approx. \$7.93M (both federal and private)
- Federal: \$2,75M (5 NSF and 3 AFOSR Grants)
- Private: \$4,88M (including multiple BPA, WAPA, NASA Glenn and DOE awards)
- Average per Year: appr \$275k in 29 years

## **Previous Research Programs between 1990 and 2016**

1. High Temperature Fatigue Crack Growth in Cast Superalloys, M. S. KUMOSA PI, sponsored by G.E. Aircraft Engines and Precision Castparts Corp., \$165,000 for one year (1990-1991).
2. High Temperature Fatigue Crack Growth in Cast Superalloys, M. S. KUMOSA PI, sponsored by G.E. Aircraft Engines and Precision Castparts Corp., \$105,000 for one year (1991-1992).
3. Deformation and Fracture of Titanium Aluminides, M. KUMOSA PI, \$105,000 for 9 months, starting date January 1, 1992, sponsored by Precision Castparts Corp., and the Oregon Metal Initiative (OMI).
4. Interfacial Fracture Phenomena in Advanced Metallic Systems, M. KUMOSA PI, Precision Castparts Corp., \$75,000 for one year, starting date July 1, 1992, including support from GE. Aircraft Engines (\$15,000) and Rockwell International (\$5,000).
5. Mixed Mode Failure Analysis of a Unidirectional Carbon/Epoxy Composite and Adhesively Bonded Composite Systems, M. KUMOSA PI, \$120,000 for two years and six months, sponsored by the National Science Foundation, Solid and Geomechanics Program, starting date July 1, 1991.
6. Failure of Composite Insulators Caused by the Combined Action of Electrical, Mechanical and Chemical Environments, M. KUMOSA PI, Bonneville Power Administration, DOE, \$260,441 for two years (including support from EPRI, (\$80,000) and WAPA (\$50,000), starting date July 1, 1992).
7. Microstructure Studies of Titanium Aluminides, M. KUMOSA PI, Precision Castparts Corp. \$25,000 for one year, starting date July 1, 1993.
8. Analytical and Experimental Studies of Substation NCIs, M. KUMOSA PI, Bonneville Power Administration, \$54,000 for one year, starting date Dec. 15, 1993.
9. Suitable Crimping Techniques for Composite Insulators, M. KUMOSA PI, NGK (Japan), \$20,000 for seven months, starting date, October 1, 1996.



10. Fracture Analysis of Composite Insulators, M. KUMOSA PI, Electric Power Research Institute, \$345,157 total, July 1, 1994 - February 28, 1998.
11. Fracture Analysis of Composite Insulators, M. KUMOSA PI, Electric Power Research Institute, \$128,000 total, March 1, 1998 - February 28, 1999.
12. Biaxial Analysis of Unidirectional Graphite Reinforced/Polyimide Composites, M. KUMOSA PI, Air Force Office of Scientific Research, \$173,648 total, March 1, 1995 - June 30, 1999.
13. Micro-Fracture Mechanisms in Glass/Polymer Insulator Materials under the Combined Effect of Mechanical, Electrical and Environmental Stresses, M. KUMOSA PI, jointly sponsored by the Bonneville Power Administration (DOE), Western Area Power Administration (DOE), Alabama Power Company, Pacific Gas & Electric, and the National Rural Electric Power Association, \$215,000, July 1996 - December 1998.
14. Failure Analysis of Unidirectional Composite Materials and Adhesive Joints Subjected to Biaxial Loadings, M. KUMOSA PI, National Science Foundation, Civil and Mechanical Systems, \$200,000 total, October 1, 1994 - December 31, 1999.
15. Biaxial Failure Analysis of Graphite Reinforced Polyimide and Epoxy Fabric Composites, M. KUMOSA PI and P. Predecki, CO-PI, Air Force Office of Scientific Research, \$101,000 total, June 1, 1997 - May 31, 2001.
16. Micro-Fracture Mechanisms in Glass/Polymer Insulator Materials under the Combined Effect of Mechanical, Electrical and Environmental Stresses, M. KUMOSA PI, Western Area Power Administration, \$20,000 for one year, starting April 1, 2000.
17. Micro-Fracture Mechanisms in Glass/Polymer Insulator Materials under the Combined Effect of Mechanical, Electrical and Environmental Stresses, M. KUMOSA PI, Western Area Power Administration, \$20,000 for one year, starting April 1, 2001.
18. Acquisition of Instrumentation for Research on Component Failure under High Temperature, Mechanical and Environmental Stress, M. KUMOSA PI, National Science Foundation, \$422,170, September 1, 1999 – August 31, 2003.
19. Fundamental Issues Regarding the High Temperature Failure Properties of Graphite/Polyimide Fabric Composites, M. KUMOSA, PI, Air Force Office of Scientific Research and NASA Glenn Research Center, \$415,000, February 15, 2000 – October 31, 2004.
20. Failure Analysis of Composite High Voltage Insulators, M. KUMOSA PI, Electric Power Research Institute, \$523,256, July 1, 2000 - December 31, 2003.
21. Investigation of Long-Term Structural Integrity of High-Temperature, Low-Sag Composite Conductors, Western Area Power Administration, Tri-State Generation and Transmission Association and Bonneville Power Administration, M. KUMOSA PI, approx. \$750,000, 6/1/2008-9/1/2014.
22. Environmental Testing and Modeling of Composites, Polymer Coatings and RTV Sealants used in HV Transmission Line Insulators, MacLean Power Systems; M. KUMOSA PI, \$190,000; Oct. 1, 2012 – June 30, 2014.
23. Titanium Electron Beam Direct Manufacturing, Lockheed Martin Corporation, M. KUMOSA PI, \$165,500, September 1, 2012- March 31, 2015.

24. Investigation of Galvanic Reaction Barriers in High Temperature High Voltage Conductors, Principal Investigator: M. KUMOSA PI, National Science Foundation, Grant Opportunities for Academic Liaison with Industry (GOALI); Total Award Amount: \$357,338; September 1, 2012 – September 30, 2017.
24. Membership Funds for the HVT Center at DU only; M. KUMOSA PI, between May 2014 and May 2019
- Bonneville Power Administration - \$400k
  - Western Area Power Administration - \$500k
  - Tri-State Generation and Transmission - \$280k
  - Lockheed Martin - \$170k (with \$50k still pending) plus \$250k in kind
  - John Crane - \$20k in cash and \$20k in kind for 2014-2015
  - Composites Technology Corporation - \$200k
  - Composites Technology Development – \$5k and \$35k in-kind in 2014-2015
  - US Bureau of Reclamation - \$400k/year in-kind between 2015 and 2018

Total DU membership HVT funding between June 1, 2014 and May 30, 2019

**Approx. \$1,575 in cash and \$600k in-kind.**

## Current and Pending Support

### Federal

1. **"Collaborative Research: I/UCRC for Novel High Voltage/Temperature Materials and Structures"**, Principal Investigator: M. KUMOSA PI, current  
Source of Support: National Science Foundation

Original Award Amount: \$602,660 (plus \$600k for UIUC and MTU) as of March 15, 2014 for 5 years, \$300k was added in Feb 2017 for UConn for 2 years

Additional \$128k was added in August 2018 until March 2019 for DU; therefore, corrected total grant amount for DU and M. Kumosa – aprox. \$730k

Period Covered: March 15, 2014 – February 28, 2020 (with one year no cost extension since March 1, 2019)

Project Location: University of Denver, Michigan Technological University, University of Illinois at Urbana-Champaign, and the University of Connecticut (since Jan 2017)

Main Site: University of Denver, M. KUMOSA overall Center director

### Private

2. **"Industry Membership Funds"** for the DU site and others of the HVT I/UCRC between June 1, 2018 and February 28, 2020; Principal Investigator: M. KUMOSA, current

- Bonneville Power Administration, DU - \$50k, current
- Western Area Power Administration, DU - \$200k, current
- Tri-State Generation and Transmission, DU - \$100k, current
- Lockheed Martin, DU - \$50k plus \$50k in-kind, pending
- Composites Technology Corporation, DU - \$80k, current
- General Cable - \$40k, current – \$20k for MTU

- Marmon – \$40k, current, \$40k for UConn
- Eversource, \$40k, current, \$40k for UConn
- G&W Electric – \$40k current , \$20k for UIUC and \$20k for UConn
- US Bureau of Reclamation, DU - \$200k/year in kind, current
- DOE Headquarters; Electricity Office, \$100k, current since Aug. 1, 2019

## **Sabbaticals**

### ***Sabbatical 2005***

Between January 1 and August 31, 2005, M. Kumosa was on sabbatical, which he spent in Denver and in Europe. In Europe, he spent two months visiting the University of Cambridge, the University of Bristol in the UK and in Poland. In Poland he visited the Technical University of Wroclaw and the Technical University of Poznan. During his sabbatical, Dr. Kumosa gave five invited lectures and presentations at Cambridge ([http://www.msm.cam.ac.uk/gordon/seminars\\_lent05.html](http://www.msm.cam.ac.uk/gordon/seminars_lent05.html)), Bristol, Poznan and Wroclaw. He also made major efforts to establish collaborative research programs with several leading European researchers.

### ***Sabbatical 2013***

M. Kumosa spent it at DU building the HVT I/UCRC. The Center was formally awarded on March 15, 2014.

## **Patents**

1. "Testing Procedure for Evaluating Diffusion and Leakage Currents in Insulators" by Armentrout, D., Kumosa, L., and Kumosa, M., US Patent, US 7327132 b2, 2008.
2. "Fault Detection in Composite Core Transmission Lines using Electric Reflectometry" by Hakansson, E. and KUMOSA, M., Provisional Patent, 62/333,776, conf. 5855, May 2016.
3. "Silicone Rubber Sealant" by M. Bleszynski, M. Kumosa. Provisional Patent No. 62/457661 "Silicone February 10, 2017, by DU.

## **Books**

1. "High Voltage/Temperature Materials", M. KUMOSA (potentially with others), in preparation, expected completion in 2020/21.

## **Dissertations**

1. KUMOSA, M., TEM Investigation of Dislocations in Fe-3% Si, M.S. Thesis, Institute of Materials Science and Applied Mechanics, Technical University of Wroclaw, 1978, Poland.
2. KUMOSA, M., Crack and Slip Phenomena at the Tip of a Terminated Twin, Ph.D. Thesis, Institute of Materials Science and Applied Mechanics, Technical University of Wroclaw, 1982, Poland.

## Published Papers in Refereed International Journals

### *Between 1980 - 1990*

1. Golaski, L., KUMOSA, M. and Hull, D., Acoustic Emission Testing of Filament Wound Pipes under Repeated Loading, Journal of Acoustic Emission, Vol. 1, No. 2, (1982) pp. 95-101.
1. KUMOSA, M., Stress and Strain Fields around Inclusions, Prace Naukowe Instytutu Materialoznawstwa i Mechaniki Technicznej Politechniki Wroclawskiej Nr. 39, Studia i Materiały Nr 26, (1983) pp. 42-60 (in Polish).
2. Golaski, L., Hull, D., and KUMOSA, M., Acoustic Emission from Filament Wound Pipes under Long Term Loading Conditions, Mechanical Behavior of Materials (1084) pp. 557-563.
3. Jerzyk, I. and KUMOSA, M., Influence of Fibre Orientations on Acoustic Emission from Filament Wound Pipes, J. Materials Science, Vol. 20 (1985) pp. 3661-3667.
4. Hull, D., KUMOSA, M. and Price, J. N., Stress Corrosion of Aligned Glass-Fibre Polyester Composite Materials, Materials Science and Technology, Vol. 1 (1985) pp. 177-182.
5. KUMOSA, M., Crack and Slip Phenomena at the Tip of a Terminated Twin, Materials Science and Engineering, Vol. 77 (1986) pp. 37-44.
6. KUMOSA, M., Hull, D. and Price J. N., Acoustic Emission from Stress Corrosion Cracks in Aligned GRP, Journal of Materials Science Vol. 22 (1987) pp. 331-336.
7. KUMOSA, M., Acoustic Emission Monitoring of Stress Corrosion Cracks in Aligned GRP, Journal of Physics D: Applied Physics, Vol. 20 (1987) pp. 69-74.
8. Barnes, J., KUMOSA, M. and Hull, D., Development of Iosipescu Shear Test, Composites Science and Technology, Vol. 28, (1987) pp. 251-268.
9. KUMOSA, M. and Hull, D., Mixed Mode Fracture of Composites using Iosipescu Shear Test, International Journal of Fracture, Vol. 35 (1987) pp. 83-102.
10. KUMOSA, M. and Hull D., Finite Element Analysis of a Circumferentially Cracked Cylindrical Shell under Uniform Tensile Loading, Engineering Fracture Mechanics, Vol. 31, No. 5 (1988) pp. 817-826.
11. KUMOSA, M. and Hull, D., Finite Element Analysis of a Circumferentially Cracked Cylindrical Shell Loaded in Torsion, Engineering Fracture Mechanics, Vol. 32, No. 1 (1989) pp. 123-136.
12. Broughton, W. R., KUMOSA, M. and Hull D., Analysis of the Iosipescu Shear Test as Applied to Unidirectional Carbon-Fibre Reinforced Composites, Composites Science and Technology, Vol. 38 (1990) pp. 299-325.

***Between 1990 – 1996***

13. Sigalas, J., KUMOSA, M. and Hull, D., Trigger Mechanisms in Energy Absorbing Glass Cloth /Epoxy Tubes, Composites Science and Technology, Vol. 40 (1991) pp. 265-287.
14. Wojnar, L. and KUMOSA, M., Quantitative Analysis of Overlapped Fracture Surfaces, Engineering Fracture Mechanics, Vol. 36, No. 4 (1990) pp. 597-609.
15. Wojnar, L. and KUMOSA, M., Advanced Quantitative Analysis of Fracture Surfaces, Materials Science and Engineering, Vol. A 128 (1990) pp. 45-53.
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## Published Reports

### Regular research reports

1. M. KUMOSA, Q. Qiu, B. Bansal, S.H. Carpenter, D. Armentrout, M. V. Balakrishnan, Y. Zhao, T. Ely, A. Chughtai and D. Smith, Fracture Analysis of Composite Insulators, Final Report to EPRI, EPRI, Palo Alto, CA; 2001. 1006293 (under contract W08019-21).\*
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## **Annual Reports from the HVT Center**

### **A. Reports to IAB of HVT Center**

18. M. KUMOSA, Center Director's Report, Semi-annual Report to IAB of HVT IUCRC, University of Illinois at Urbana-Champaign, November 17-18, 2014.
19. M. KUMOSA, Center Director's Annual Report to IAB of HVT IUCRC, May 19-20, 2015, Michigan Technological University.
20. M. KUMOSA, et al, Annual Progress Reports to IAB of HVT IUCRC, May 19-20, 2015, Michigan Technological University including:
  - 20 a. Corrosion of Transmission Conductors, E. Hakansson, M. KUMOSA, et al., Annual Report to HVT Center.
  - 20 b. Impact Damage to HTLS Conductors, Insulators, Transformers, Substation, D. Waters, M. Kumosa, et al., Annual Report to HVT Center.
  - 20 c. Glass Fibers and their Polymer Based Composites under Excessive Corrosion, UV and Temperature Conditions, E. Solis-Ramos, Taylor, Lu, M. KUMOSA, et al., Annual Report to HVT Center.
  - 20 d. Nanotechnology of HTLS Polymer Core Conductor Materials for Aging Prevention, J. Hoffman, M. KUMOSA, et. al., Annual Report to HVT Center.
  - 20 e. Multiscale Characterization and Modeling of Metal Matrix (Nano)Composites, E. Solis-Ramos, I. Jasiuk (UIUC), M. KUMOSA, et al., Annual Report to HVT Center.
  - 20 f. Diagnostics of RTV1 and RTV2 HV Silicone Rubber Components, Nanocoatings and Silicone Rubber Nanocomposites for HV and other Applications, M. Bleszynski, B. Allen, M. KUMOSA, et al., Annual Report to HVT Center.
21. M. KUMOSA, Center Director's Annual Report to IAB of HVT IUCRC, May 17-18, 2017 University of Illinois at Urbana-Champaign.
22. M. MKUMOSA, et al., Annual Progress Reports to IAB of HVT IUCRC, May 17-18, 2017, University of Illinois at Urbana-Champaign including:
  - 22 a. Physical Damage to HV Transmission Infrastructure, C. Henderson, D. Waters, M. KUMOSA, et al., Annual Report to HVT Center.
  - 22 b. Additive Manufacturing, Novel Alloys and Composites, and Metallic Glasses, B. Grell, E. Clark, E. Solis-Ramos, M. KUMOSA, et al., Annual Report to HVT Center.
  - 22 c. Aging Prevention of Polymeric Materials using Nanotechnology and other Methods, J. Hoffman, M. KUMOSA, et. al., Annual Report to HVT Center.
  - 22 d. Synergistic Aging of Affordable Polymer Matrix Composite, T. Lu, E. Solis-Ramos, M. KUMOSA, et al., Annual Report to HVT Center.

- 22 e. Galvanic Corrosion of Aluminum/Carbon Composite Systems, E. Hakansson, M. KUMOSA, et al., Annual Report to HVT Center.
- 22 f. Diagnostics of RTV1 and RTV2 HV Silicone Rubber Components, Nanocoatings and Silicone Rubber Nanocomposites for HV and other Applications, M. Bleszynski, B. Allen, M. KUMOSA, et al., Annual Report to HVT Center.
23. M. KUMOSA, Center's Director Annual Report to IAB of HVT I/UCRC, May 17-18, 2017, University of Denver.
24. M. KUMOSA et al, Annual Progress Reports to IAB of HVT I/UCRC, May 17-18, 2017, University of Denver including:
- 24 a. Aging Resistant RTV Silicone Rubbers and their Nanocomposites, M. Bleszynski, B. Allen, M. KUMOSA, et al., Annual Report to HVT Center.
- 24 b. Durability Enhancements of Icephobic Barriers, J. Middleton, T. Woll, M. KUMOSA, et al., Annual Report to HVT Center.
- 24 c. Effect of Powder Oxidation on Mechanical Properties of Ti-6Al-4V Parts Made by Additive Manufacturing, W. Grell, E. Solis-Ramos, M. KUMOSA, et al, Annual Report to HVT Center.
- 24 d. Manufacturing of Materials for Aging Prevention of Fiber Reinforced PMC, J. Hoffman, S. Khadka, M. KUMOSA, et al., Annual Report to HVT.
- 24 e. Synergistic Effects in Environmental Degradation of Glass and Basalt Composites, E. Solis-Ramos, T. Lu, M. KUMOSA, et al., Annual Report to HVT Center.
- 24 f. Prevention of High Velocity Impact Damage to Substations, C. Henderson, C. DeFrance, M. KUMOSA, et al., Annual Report to HVT Center.
- 24 g. HVT Monitoring using Fiber Bragg Gratings and other Techniques, J. Hoffman, D. Waters, S. Khadka, M. KUMOSA, et al., Annual Report to HVT.
25. M. KUMOSA, Center's Director Report to IAB of HVT I/UCRC, May 14 -16, 2018, University of Illinois at Urbana-Champaign
26. M. KUMOSA et al, Annual Progress Reports to IAB of HVT I/UCRC, May 14-16, 2018, University of Illinois at Urbana-Champaign, including:
- 26 a. Aging Resistant Silicone Rubbers and their Composites, M. Bleszynski, B. Allen and M. KUMOSA, Annual Report to HVT Center.
- 26 b. Durability Enhancement of Icephobic Barriers, M. Bleszynski, J. Middleton, R. Woll and M. KUMOSA, Annual Report to HVT Center.
- 26 c. Current Issues in Metallic Additive Manufacturing, M. KUMOSA, W. Grell, et al, Annual Report to HVT Center.
- 26 d. Aging Prevention and Sensing of HVT Polymer Matrix Composites, S. Khadka, J. Hoffman and M. KUMOSA, Annual Report to HVT Center.
- 26 e. Prevention of High Velocity Impact Damage to Substations, C. Henderson and M. KUMOSA, Annual Report to HVT Center.



26 f. Health Monitoring of HVT Structures using FBG Sensors, J. Hoffman, D. Waters and M. KUMOSA, Annual Report to HVT Center.

26 g. Recycling Fiber Reinforced Polymer Matrix Composites, E. Edward and M. KUMOSA, Annual Report to HVT Center.

26 h. Synergistic Effects in Environmental Degradation of Glass and Basalt Polymer Matrix Composites, E. Solis-Ramos, T. Lu and M. KUMOSA, Final Report to HVT Center.

#### **B. NSF Annual HVT Reports from DU**

27. M. KUMOSA, Annual Report to NSF from DU, HVT Center, February 2015.

28. M. KUMOSA, Annual Report to NSF from DU, HVT Center, February 2016.

29. M. KUMOSA, Annual Report to NSF from DU, HVT Center, February 2017.

30. M. KUMOSA, Annual Report to NSF from DU, HVT Center, February 2018.

31. M. KUMOSA, Annual Report to NSF from DU, HVT Center, February 2019.

#### **C. NSF Annual Summary Reports from HVT Center**

32. M. KUMOSA, Annual Summary Director's Report to the National Science Foundation Industry/University Cooperative Research Center for Novel High Voltage/Temperature Materials and Structures March 1, 2016 - February 28, 2017, copy available.

33. M. KUMOSA, Annual Summary Director's Report to the National Science Foundation Industry/University Cooperative Research Center for Novel High Voltage/Temperature Materials and Structures March 1, 2017- February 28, 2018, copy available.

34. M. KUMOSA, Annual Summary Director's Report to the National Science Foundation Industry/University Cooperative Research Center for Novel High Voltage/Temperature Materials and Structures March 1, 2018- February 28, 2010, copy available.

## Maciej S. Kumosa - Biographical Sketch

### Education



The Technical University of Wrocław, from which Dr. Kumosa graduated, is one of the largest technical universities in Poland. At the time of his graduation in 1982, the University consisted of approximately 30 large research institutes, 20,000 undergraduate and MS graduate students, and approximately 1,000 graduate Ph.D. students in a variety of technical and scientific disciplines with the exception of life sciences. Since 2002, the Technical University of Wrocław has been usually ranked the #1 among all technical universities in Poland in several national rankings.

Dr. Kumosa's Ph.D. program in Applied Mechanics and Materials Science was jointly sponsored by the Technical University of Wrocław and the National Science Foundation (NSF) of the United States of America (Marie Curie Foundation, International Programs). His Polish academic advisor was Professor L. Golaski, whereas Professor K. Ono from the University of California Los Angeles (UCLA) was his American advisor. As part of Dr. Kumosa's Ph.D. program, he was invited in 1981 by the NSF to visit UCLA as well as other research organizations in the USA. This was his first contact with the United States.

### Employment History



After graduating, in 1983, Dr. Kumosa was appointed an Assistant Professor of Applied Mechanics and Materials Science at the University of Wrocław. In January 1984, due to mostly economic reasons, he left Poland and sought academic employment abroad. Initially, between January 1984 and December 1984, he worked as a Visiting Research Fellow at the University of Liverpool. Then, in January 1985, he moved to Cambridge, England where he spent six fascinating years. In the Department of Materials Science and Metallurgy at the University of Cambridge working with Professor D. Hull, FRS, Dr. Kumosa was exposed to state-of-the-art material science research and, in particular, advanced composite research. The knowledge and experience he gained at Cambridge shaped his entire academic career in subsequent years.

In 1990, Dr. Kumosa left Cambridge and accepted an academic appointment at the Oregon Graduate Institute of Science & Technology (OGI) in Portland, Oregon. Between 1990 and 1996 he was an Associate Professor at OGI in two departments; initially in Materials Science and Engineering and then Applied Physics and Electrical Engineering. At OGI, Dr. Kumosa built large research programs in the area of high voltage composite insulators (supported by DOE, EPRI and several large US utilities) and in the area of high temperature polymer based composites for aerospace applications (supported by NSF, AFOSR, the State of Oregon and others).

In 1996, due to family reasons, Dr. Kumosa left OGI and accepted an academic appointment in the Department of Engineering at the University of Denver (DU), where he is presently a tenured Professor of Mechanical Engineering. In 2006, Dr. Kumosa became a John Evans Professor (the highest award at DU for research and scholarly work).

### **Research Centers and Academic Departments Built by M. Kumosa at OGI and DU**

At DU, in 1996, jointly with Dr. Paul Predecki and Dr. Steve Carpenter, Dr. Kumosa created the Center for Advanced Materials and Structures. The Center was internationally recognized attracting significant research funds from major US federal and private funding organizations.

In 2006, jointly with several (about 25) faculty members from the School of Natural Sciences and Mathematics (NSM) and the School of Engineering and Computer Science (SECS) Dr. Kumosa built a new interdisciplinary research center; the Center for Nanoscale Science and Engineering (the “Nano Center”). The Center was in operation until 2011. The Center developed a graduate PhD program in Nanoscale Science and Engineering. It also attracted limited federal (NSF) and private (DU) educational and research funds. In 2011-12, Dr. Kumosa started replacing the “Nano Center” with a much larger and more successful I/UCRC Center (see below)

Between 2011 and 2014, Dr. M. Kumosa jointly with his partners from the University of Illinois at Urbana-Champaign and Michigan Technological University (see below) built the National Science Foundation Industry/University Cooperative Research Center for Novel High Voltage/Temperature Materials and Structures ([www.HVTCenter.org](http://www.HVTCenter.org)). The Center was awarded by NSF on March 15, 2014.

In addition to the research centers, Dr. Kumosa built the Department of Mechanical and Materials Engineering, MME ([www.mme.du.edu](http://www.mme.du.edu)) as its first Chair between Sep. 2007 and Nov. 2009. The MME department was formed in 2007 after the split of the former Engineering department into the MME department and the Department of Electrical and Computer Engineering.

## History of HVT Center

The HVT Center ([www.HVT.Center.org](http://www.HVT.Center.org)) was awarded by the National Science Foundation in March 2014 to three Universities (University of Denver, Michigan Technological University and University of Illinois at Urbana-Champaign) and then expanded in Jan 2017 by adding the University of Connecticut (see below). It was built based primarily on M. Kumosa's research efforts and accomplishments in the areas of HT-HV materials and technologies between 1990 and 2012-3 (see above). The Center combines both the HV and HT aspects of advanced materials and structures and is now rapidly expanding into other areas related to the application of advanced materials and structures in extreme environments.

The Center was evaluated by its members for 2017. For the quality of its research, meetings and management, the Center received 4.1/5, 4.2/5 and 4.2/5, respectively, all noticeably above the national averages. The evaluations for 2016 were very similar (for research 4.8/5).

As of March 2019, the Center graduated 22 PhDs, 14 MS students and is currently supporting 34 graduate students (mostly PhDs) at its 4 sites. It has produced about 103 journal papers (as of August 2019), numerous conference papers and 2 patents.

The HVT Center is presently funded in a no cost extension year by 12 large US corporations, federal agencies (DOE) and NSF (see the funding section of Dr. Kumosa's CV).

Most importantly, the entire HVT Center satisfied all NSF I/UCRC requirements and expectations and was ranked in good standing by NSF in 2014, 2015, 2016, 2017 and 2018. At present the Center is completing Phase I of its operation in a no cost extension year and preparing for Phase II starting in 2020.

## Current Academic Sites

- University of Denver, lead site. Dr. M. Kumosa, overall Center Director
- Michigan Technological University (MTU); one of three original HVT sites  
Dr. Gregory Odegard, Professor and HVT Site Director ([gmodegar@mtu.edu](mailto:gmodegar@mtu.edu))
- University of Connecticut (UConn); joined in February 2017  
Dr. Yang Cao, Associate Professor and HVT Site Director ([yang.cao@uconn.edu](mailto:yang.cao@uconn.edu))
- University of Illinois at Urbana-Champaign (UIUC); one of three original sites  
Dr. Iwona Jasiuk, Professor and HVT Site Director ([ijasiuk@illinois.edu](mailto:ijasiuk@illinois.edu))

## Industries (19) supporting HVT from 2014 to the present:

ABB, Boeing, Bonneville Power Administration, BP, CTC Global, Composites Technology Development, Eversource, G&W, General Cable, General Electric, John Crane, Marmon Engineered Wire & Cable, Lockheed Martin Space Systems, Prysmian Group, Southwire, Tri-State Transmission and Distribution, USi, US Bureau of Reclamation, Western Area Power Administration.

## Funding for the first 5 years from March 15, 2014 to May 14, 2019;

- \$2.60M in industrial fees
- \$1.65M in federal funding
- \$10M-12M in various leveraged funds

## Funding in no cost extension Year between March 1, 2019 and Feb 2020

- NSF - \$0k

- Industrial and federal fees – \$480k plus \$100k in kind including; \$40k from ABB, \$50k from BPA, \$100k from DOE Headquarters, \$40k from G&W, \$40k from CTC Global, \$50k from Eversource, \$40k from Marmon, \$50k from Tri-State, \$100k from WAPA and \$100k (in-kind) from USBR

### **Research Goals and Objectives:**

The I/UCRC for Novel High Voltage/Temperature Materials and Structures (“HVT Center”) works jointly with the electric utility, aerospace, nuclear, military, environmental, automotive, health, and other industries with needs of novel HV/T materials and structures.

The objectives of the Center are: (1) Design of novel and evaluation of existing HV/T energy transmission/transfer multifunctional materials for next generation composite conductors, insulators, underground cables, towers, and other electric power transmission structures; (2) Design and development of novel advanced high energy transfer materials for aerospace, oil/gas, automotive, and other industrial applications; (3) Failure prediction and prevention of HV/T materials and structures under in-service conditions through state-of-the-art multi-scale modeling and material performance evaluations; (4) Development of new failure monitoring techniques and material repair methods in HV/T materials under laboratory conditions and their subsequent transfer to in-service inspection and repair.

The HVT Center has a diverse and interdisciplinary educational, research and business environment for (1) undergraduate and graduate students, including those from underrepresented groups, funded by the research projects of the Center; (2) faculty members from a variety of disciplines, including junior faculty starting their academic careers; (3) utility, aerospace and national lab engineers and designers developing various types of HV/T materials and structures; and (4) utility managers supervising HV transmission lines across the country.

The Center enhances the reputation of U.S. HV/T manufacturing around the world and, in particular, improves the level of confidence among the potential users of novel HV/T structures. The center targets long-term benefit to infrastructure, manufacturing, energy transport and efficiency of the electric grid, and the durability of other HV/T and high energy transfer structures.

### **Current HVT Research Projects**

#### **Research Area 1. Multiscale Design and Development of Novel HVT Materials**

- 1.2 Aluminum Alloys for High Conductivity and Strength (MTU)
- 1.3 Aging Resistant RTV Silicone Rubbers and their Nanocomposites (DU)
- 1.5 Development of Durable Icephobic Barriers (DU)
- 1.6 HVDC/MVDC Cabling: Electronic Structure of Polyolefin (UConn)
- 1.7 HVDC/MVDC Cabling – Space Charge Dynamics (UConn)

#### **Research Area 2. Advanced Manufacturing of HVT Materials**

- 2.2 High Temperature/Voltage Polymers and Nanocomposite (UIUC)
- 2.5 Titanium (Ti) Intermetallics, Ti Alloys and Superalloys for Extreme HT Aerospace, Automotive and other Applications (DU)

#### **Research Area 3. Environmental Degradation of HVT Materials and Structures**

- 3.4 In-Situ Sensing of Manufacturing and Aging of HVT Polymer Matrix Composites (DU)
- 3.5 Recycling Fiber Reinforced Polymer Matrix Composite Materials (DU)

**Research Area 4. Damage Prevention of HVT Materials and Structures**

- 4.2 Prevention of High Velocity Impact Damage to Substations (DU)
- 4.4 HVDC Grid Hardening against Geomagnetic Disturbance (UConn)
- 4.5 Discharge Resistant Materials for Circuit Breaker (UConn)

**Research Area 5. Monitoring and Diagnosis of HVT Structures/Equipment**

- 5.1 Applications of FBG Sensors in HVT Materials and Structures (DU)
- 5.5 Vibration of HVT Cable Structures (UIUC)
- 5.6 Photo-acoustic Based Dissolved Gas Analysis (UConn)
- 5.7 HT FBG Sensors for Temperature and Strain Sensing Applications (DU)
- 5.8 Remote Sensing of HVT Structures Using Hyperspectral Imaging (DU)