

Stephen M. Hsu



Professor of Engineering and Applied Science, Mechanical and Aerospace Engineering
George Washington University

External positions:

- ✦ Member, Virginia Joint Commission on Technology & Science, Energy Advisory Committee
- ✦ Member, Loudoun County Sustainable Energy Advisory Task Force
- ✦ Member, Virginian for Reliable Energy
- ✦ Member, Northern Virginia Technology Council Smart Energy Committee
- ✦ Member, Renewable Natural Resources Foundation
- ✦ Member, Expert advisory Panel on energy, Metropolitan Council of governments
- ✦ Member, Chesapeake Crescent Initiative
- ✦ Member, IEEE Clean Vehicle Transportation Discussion Group

Major research areas:

- Energy efficient buildings
- Smart microgrids
- Wind energy
- Fuel economy
- Advanced materials, nanocomposites
- Advanced Lubrication of materials
- Artificial joint replacement materials
- Integrated surface technology to control friction and drag
- Ultrahydrophobic surfaces

Laboratories:

Energy efficient laboratory- Cameron Plint tester, ring on block tester, spin stand, Four ball tester, pin on disk tester with high speed video camera

Nanomaterials laboratory- world class antivibration slabs in Class 100 clean environment.

Major equipment include AFM, Hi temp. microindenter, nanoindenter, dip coating, grazing angle FTIR

Access to Howard University NSF Nanofab and NIST Nanofab facilities

Wind Energy Research and Partnership

We responded to the DOE Wind Energy Consortia Center solicitation in 2009. As required by the solicitation, we formed a wind energy industrial consortium of 11 companies (ABS consulting, AES, ARI wind, Bayer Materials, Conexo, EMS of Broadwind, Generation Energy, Nordic wind, Northern Power, Vesper wind, Viryd). An academic research team was organized to develop the technical agenda, consisting of 6 GWU faculty members, one faculty from the US Naval Academy, and three senior scientists from National Research Center (NRC) of Canada. We propose to develop novel dual reinforced thermoplastic nanocomposites, smart blade controls, cold spray for large area coatings, self-repairing gears to minimize maintenance, etc. These new technologies will have the potential to halve the cost and double the performance. The 11 companies contributed over \$1M cash and in-kind support for the proposal. We also proposed a comprehensive education program providing skilled operators, engineers, MS, PhDs professionals to overcome the manpower shortage in wind.

We are currently funded by DOE to develop a wind energy curriculum at GWU. We are working with the consortium members on the curriculum as well as pursuing some technical projects.

Energy Efficient Buildings Research and Partnership

In 2010, DOE issued a call for an Energy Efficient Building Design Hub together with NIST, EDA, Education, SBA, NSF, and Labor. We participated in a consortium formation and organization led by the Chesapeake Crescent Initiative (CCI) (DC, VA, MD organization), including 10 Universities (UMD, UDel, JHU, GWU, WVa, UVa, VT, GMU, JMU, GT), major developers, technical and trade associations, GSA, in the mid-Atlantic Region (including DC, VA, MD, Delaware, WVA governments), to respond to this solicitation. We led and coordinate the basic research section of the proposal (including UDel, WVA, UMD, VT, and GWU) on multifunctional materials, nanocomposites, embedded sensors, and autochromatic windows. GWU faculty members participated from the School of Business, Law, Columbia Arts and Sciences, and School of Engineering.

With the network firmly in place, we have been working with Va Tech and industries on microgrids of smart buildings. Current research topics include: advanced air conditioner compressors, smart building controls, multifunctional materials.

Transportation technologies

We are working with Toyota, Cummins, Ashland Oil, R.T.Vanderbilt, ORNL, NIST, GM, Shell to develop fuel efficient technologies.

- ✚ Integrated surface technology including surface texture, thin films, and bonded molecular assemblies to effect friction reduction (potential fuel economy gain: 3-5%)

- ✚ Biomimetic surface design and fabrication based on lotus leaf and shark skin for drag reduction and antifouling protection
- ✚ Advanced lubricant design to enable low viscosity lubricant to function without wear and durability penalties (potential fuel economy gain: 3-7%)
- ✚ Nanoparticle based self-healing materials
- ✚ Nanocomposites for weight reduction

Current funding from DOE EERE, Wind energy, Cummins Inc.

Group consists of undergraduate students, graduate students, postdocs, and Sr. research scientist.

Short Bio of Stephen Hsu

Stephen obtained his BS at Virginia Tech and MS and PhD degrees in Engineering from the Pennsylvania State University. After graduation, he joined the Amoco Chemicals Research Lab in Naperville, Illinois conducting research on engine efficiency and fuel economy. In 1978, he joined National Institute of Standards and Technology, NIST to lead a US Congressionally mandated program to develop standards and guidelines for the use of recycled oils for the US. After successfully concluded the program in 1984, he established his own research group and worked on various aspects of tribology, materials, fuel economy, energy efficiency, standards, and nanotechnology.

In 1985, he entered into the Senior Executive Service (SES) to create the Ceramic Division to lead the Nation's advance in new materials. He was successful in acquiring two congressional budget initiatives for the division and made the division a national center of excellence.

In 1992, he went back to basic research and began working closely with various industries on a variety of technical issues challenging the economy: machining of advanced materials, magnetic hard disk interface, materials development and selection, frictional resistance and fuel economy, and nanomechanical properties of nanomaterials.

He published some 250 papers, received 7 US patents, and gave over 40 plenary lectures in international conferences. He was a visiting Professor at Pa. State, Esback Fellow at Northwestern University, and Adjunct Professor at University of Maryland where he supervised MS and Ph D theses. He received numerous awards and honors for his work.

In Jan 2007, he joined George Washington University as a Professor of Engineering and Applied Science. He spent a year in City University of Hong Kong as a Chaired Professor and Head of the Manufacturing Engineering Department before returning to GWU to lead the SEAS energy initiative. Currently he focuses on wind energy, energy efficient buildings, net zero-energy house, smart grids, new nanomaterials for lightweighting of vehicles, fuel economy, advanced materials for energy, and an integrated surface technology for various energy applications.

He has extensive domestic and international network through his leadership role in two key international organizations: he was the Chair of VAMAS (Versailles Agreement on Advanced materials and Standards, a G7 ministerial organization), and he leads the International Energy Agency Implementing Agreement on Advanced materials for Transportation, comprised of 8 countries working on new materials. Under his leadership, over 85 ASTM ISO standards on materials have been established, facilitating exchange and commerce of advanced materials around the world.

He is a Fellow of ASME, STLE, and a member of ASTM, AcerS, ASM, SAE, and AICHE. He served on the Editorial Boards of Tribology Letters, Tribology International, as well as foreign expert reviewers for European Science Foundation, Australia, Canada, Singapore, Hong Kong, Sweden, etc.

Recent talks

“Fuel economy improvement in trucks through advanced surface technology and low viscosity fluids,” Invited talk, Cummins Tech Center, Columbus, Indiana, Sept. 2, 2011.

“Lubrication science and technology: a 21st Century perspective,” **Plenary Lecture**, the 6th International Tribology Conference, Lanzhou, China, August 19-22, 2011.

“Nanotechnology as a source of innovation for energy and environmental challenges,” **Open Plenary Lecture** for the joint session of the 3rd European Conference on EcoTribology and 4th Vienna International conference on Nanotechnology, Vienna, Austria, June 7-9, 2011.

“Fuel economy through surface textures,” Invited talk, IEA Technical Symposium, Berlin, Germany, March 28, 2011.

“Nanomaterials for transportation applications,” invited talk, World Materials Perspective, the First International Material Summit, Materialia, Nancy, France, March 31, 2011.

“Energy innovations at GWU Ashburn,” invited talk, Northern Virginia Technology Council, University Innovation workshop, NVTC, Feb 24, 2011.

“Future of Tribology and Tribochemistry Research,” Invited talk, Tsinghua University, Beijing, China, Dec. 21, 2010.

“Tribology research in the age of transformative technologies,” **Opening Plenary Lecture**, International Tribology Congress, AsisTrib 2010, Perth, Australia, Dec. 5-9, 2010.

“Fundamental tribochemical mechanisms in Chemomechanical polishing process,” Invited talk, Tsinghua University, Oct. 28, 2010.

Invited Panelist, Future Green Energy, GreenGov Symposium, George Washington University, Washington DC, Oct. 5-7, 2010.

Invited panelist, Smart Grid 101, GreenGov Symposium, George Washington University, Washington DC, Oct. 5-7, 2010.

“Principles of surface texture design,” **Keynote lecture**, China International Workshop on Surface Texturing, Tsinghua University, Beijing, China, September 19-21, 2010.

“Grand Challenges of Energy: Status of technologies,” Invited talk, Tsinghua University, Beijing, China, September 16, 2010.

“Energy and Climate change: materials and tribology issues in a new world,” Invited talk, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou, China, September 13, 2020.

“Smart microgrid concept,” invited talk, National Capital Planning Commission, Washington DC, September 10, 2010.

“Microgrid demonstration project in Washington DC,” invited talk, GSA HQ, Washington DC, Aug. 18, 2010.

“Progress in an integrated surface technology in reducing parasitic losses in diesel engines,” invited talk, Cummins Tech Center, Columbus, Indiana, July 29, 2010.

“Fuel economy related research at GWU,” Toyota Co. visit to Ashburn, Va., July 20, 2010

“Measurement of nano- micro-particles in a polymer matrix using AFM,” The 12th International Congress on Mesomechanics, National Taiwan University of Science and Technology (NTUST) in Taipei, Taiwan, June 21 to 25, 2010.

“A new AFM test method for nanocomposite materials,” IEA Technical Symposium, Shanghai Institute of Ceramics, Shanghai, China, June 3, 2010

“Challenges and Opportunities in Nanotribology,” Invited talk, STLE annual conference, Las Vegas, May 16-20, 2010

“The Energy Challenge: the answer may be blowing in the wind,” invited talk, GWU Society of Emeriti lunch Speaker, Feb. 19, 2010

“Wind energy today”, SEAS NAC meeting Panelist, Oct. 30, 2009.

“Fatigue mechanisms of materials,” Invited talk, The IEEE Vehicular Technology Society, ASME, the National Capital Area Land Transportation Committee joint meeting, Washington DC, Oct. 13, 2009.

“Energy and sustainability research at SEAS,” Lockheed Martin Corp visit to GWU, Oct. 9, 2009

“Energy and climate change,” Opening Seminar on Engineering Challenges in the 21st Century Seminar Series, SEAS, Fall 2009, Oct. 5, GWU

Energy and sustainability,” President Knapp’s visit to SEAS, Sept. 30, 2009

“Tribological Challenges in the 21st Century,” **Keynote address**, Forefront of Tribology, an invitation only conference, Sendai Japan, Sept 12-14, 2009

“History of Boundary Lubrication and Energy savings”, **Keynote**, Hsu, S. M., Proceedings of the 4th World Tribology Congress, Kyoto, Japan, Sept 6-11, 2009

“Trends in Environmental Tribology,” Invited talk, Hsu, S. M., Proceedings of the 4th World Tribology Congress, Kyoto, Japan, Sept 6-11, 2009

“Scaling Issues in Tribochemistry,” **Keynote Address**, Tribochemistry Kyoto 2009, Kyoto, Sept 2-4, 2009

“Fundamental aspects of controlling interfacial properties by surface textures,” S. M. Hsu, **keynote address**, Surface Engineering for Multi-functional Applications Symposium, International Conference on Multifunctional materials and structures, July 28-31, 2008, Hong Kong.

“An integrated surface technology to reduce fuel consumption,” IEA Technical Symposium, IEA HQ, Paris, France, June 11, 2009.

“International Energy Agency, Implementing agreement on Advanced Materials strategy Plan,” IEA Committee on Research and Technology (CERT), IEA HQ, Paris, France, June 9-10, 2009

“An integrated surface technology for fuel economy improvement,” DOE Annual Merit Review Meeting, Crystal Gateway Marriott, Arlington, VA, May 21, 2009

“From coatings to protect substrate to coatings to create new functions,” Invited talk, STLE Annual Conference, Coronado Hotel, Orlando, Florida, May 18-20, 2009

“Boundary layer in water lubricated seals,” Invited talk, STLE Annual Conference, Coronado Hotel, Orlando, Florida, May 18-20, 2009

“The origin and mechanism of micro-pitting in Wind turbine gears,” Invited speaker, National Wind Technology Center Invited Workshop, Boulder, CO, April 15-16, 2009.

“Tribochemistry in boundary lubrication of materials,” **Opening Plenary Lecture**, Hsu, S. M., ECI Conference on Boundary Lubrication, Seville, Spain, March 30-April 3, 2009

“Nano-Tribochemistry: corrosion or enhanced lubrication?” **Opening Plenary Lecture**, Vienna Nano 09 & Tribocorrosion 09 joint conference, Vienna, Austria March 18, 2009