

Dr. Robert A. (Drew) Fleming
Assistant Professor of Mechanical Engineering
College of Engineering and Computer Science
Arkansas State University

Education:

University of Arkansas	Mechanical Engineering	Ph.D., 2017
<i>Dissertation: Deformation Behavior of Al/a-Si Core-Shell Nanostructures</i>		
<i>Advisor: Dr. Min Zou</i>		
University of Arkansas	Mechanical Engineering	MSME, 2012
<i>Thesis: Silica Nanoparticle-Based Coatings with Superhydrophilic and Superhydrophobic Properties</i>		
<i>Advisor: Dr. Min Zou</i>		
University of Arkansas	Mechanical Engineering	BSME (<i>Magna cum Laude</i>), 2009

Appointments:

08/19 – Present	Assistant Professor of Mechanical Engineering, Arkansas State University
01/15 – 07/19	Research Engineer, WattGlass, Fayetteville, AR
06/10 – 12/16	Graduate Researcher in the Nanomechanics and Tribology Laboratory, Institute for Nanoscience and Engineering, University of Arkansas
08/09 – 12/09	Heat Transfer Laboratory Instructor (Teaching Assistantship), Department of Mechanical Science and Engineering, University of Illinois – Urbana-Champaign
05/07 – 08/09	Cleanroom Operator, High Density Electronics Center, University of Arkansas

Publications:

1. Moffitt, S.L., Riley, C., Ellis, B.H., **Fleming, R.A.**, Thompson, C.S., Burton, P.D., Gordon, M.E., Zakutayev, A., and Schelhas, L.T. (2020), “Combined Spatially Resolved Characterization of Antireflection and Antisoiling Coatings for PV Module Glass,” *ACS Combinatorial Science*, 22, 4, 197-203, DOI:10.1021/acscmbosci.9b00213
2. Moffitt, S.L, **Fleming, R.A.**, Thompson, C.S., Titus, C.J., Kim, E., Leu, L., Toney, M.F., and Schelhas, L.T. (2019), “Advanced X-ray Scattering and Spectroscopy Characterization of an Anti-Soiling Coating for Solar Module Glass,” *ACS Applied Energy Materials*, 2, 11, 7870-7878, DOI:10.1021/acsaem.9b01316
3. **Fleming, R.A.** and Zou, M. (2018), “Nanostructure-Textured Surfaces with Low Friction and High Deformation Resistance,” *Tribology Transactions*, 61(1), 80-87, DOI:10.1080/10402004.2016.1274066 (Edmond E. Bisson Award from STLE for best paper published in 2018.)
4. Choudhury, D., Ranuša, M., **Fleming, R.A.**, Vrbka, M., Křupka, I., Teeter, M.G., Goss, J., and Zou, M. (2018), “Mechanical wear and oxidative degradation analysis of retrieved ultra high molecular weight polyethylene acetabular cups,” *Journal of Mechanical Behavior of Biomedical Materials*, 79, 314-323, DOI:10.1016/j.jmbbm.2018.01.003
5. Steck, J.G., **Fleming, R.A.**, Goss, J.A., and Zou, M. (2018), “Deformation and fatigue resistance of Al/a-Si core-shell nanostructures subjected to cyclic nanoindentation,” *Applied Surface Science*, 433, 617-626, DOI:10.1016/j.apsusc.2017.09.255
6. **Fleming, R.A.**, Goss, J.A., and Zou, M. (2017), “Material Dimensionality Effects on the Nanoindentation Behavior of Al/a-Si Core-Shell Nanostructures,” *Applied Surface Science*, 412, 96-104, DOI:10.1016/j.apsusc.2017.03.221
7. **Fleming, R.A.** and Zou, M. (2017), “The Effects of Confined Core Volume on the Mechanical Behavior of Al/a-Si Core-Shell Nanostructures,” *Acta Materialia*, 128, 149-159, DOI: 10.1016/j.actamat.2017.02.009
8. Choudhury, D., Lackner, J., **Fleming, R.A.**, Goss, J., Chen, J., and Zou, M. (2017), “Diamond-like carbon coatings with zirconium-containing interlayers for orthopedic implants,” *Journal of the Mechanical Behavior of Biomedical Materials*, 68, 51-61, DOI:10.1016/j.jmbbm.2017.01.023

9. Beckford, S., Cai, J., **Fleming, R.A.**, and Zou, M. (2016), "The Effects of Graphite Filler on the Tribological Properties of Polydopamine/PTFE Coatings," *Tribology Letters*, 64(3), 42, DOI:10.1007/s11249-016-0777-5
10. Beckford, S., Mathurin, L., Chen, J., **Fleming, R.A.**, and Zou, M. (2016), "The effects of polydopamine coated Cu nanoparticles on the tribological properties of polydopamine/PTFE coatings," *Tribology International*, 103, 87-94, DOI:10.1016/j.triboint.2016.06.031
11. **Fleming, R.A.** and Zou, M. (2014), "Fabrication of Stable Superhydrophilic Surfaces on Titanium Substrates," *Superhydrophilic Surfaces: Special Issue of the Journal of Adhesion Science and Technology (JAST)*, 28, 823-832, DOI:10.1080/01694243.2012.697754 (Invited paper, first published online in 2012.)
12. **Fleming, R.A.** and Zou, M. (2013), "Silica Nanoparticle-based Films on Titanium Substrates with Long-term Superhydrophilic and Superhydrophobic Stability," *Applied Surface Science*, 280, 820-827, DOI:10.1016/j.apsusc.2013.05.068
13. Thompson, C.S., **Fleming, R.A.**, and Zou, M. (2013), "Transparent Self-Cleaning and Antifogging Nanoparticle Films," *Solar Energy Materials and Solar Cells*, 115, 108-113, DOI:10.1016/j.solmat.2013.03.030
14. Thompson, C.S., **Fleming, R.A.**, and Zou, M. (2012), "Extreme Surface Wetting for Solar Panel Applications," *Advancing Microelectronics*, 39(6), 12-15, DOI:10.4071/amim-39-6 (Invited paper)
15. Tidwell, W., Scott, D., Wang, H., **Fleming, R.A.**, Zou, M. (2011), "Nanoindentation Study of Deformation-Resistant Al/a-Si Core-Shell Nanostructures," *Acta Materialia*, 59(15), 6110-6116, DOI:10.1016/j.actamat.2011.06.023
16. Morton, B.D., Wang, H., **Fleming, R.A.**, Zou, M. (2010), "Nanoscale Surface Engineering with Deformation-Resistant Core-Shell Nanostructures," *Tribology Letters*, 42(1), 51-58, DOI:10.1007/s11249-011-9747-0

Conference Presentations/Posters:

1. Adawi, M. and **Fleming, R.A.**, "Accelerated Soiling and Cementation Testing for PV Cover Glass Materials," *2022 NREL Virtual Photovoltaic Reliability Workshop*, February 21-25, 2022.
2. **Fleming, R.A.**, "Dislocation Dynamics in Core-Shell Nanostructures," *2021 ASME IMECE*, Virtual Conference, November 1-5, 2021.
3. **Fleming, R.A.**, "Fundamental Studies of Soiling and Cementation of PV Cover Glass Materials: Addressing Reliability with Advanced X-ray Scattering/Spectroscopy and First Principles Modeling," *2021 DOE BES Materials Chemistry Program PI Meeting*, Virtual Conference, July 20-22, 2021.
4. Hughes, S. and **Fleming, R.A.**, "Molecular Dynamics Investigation of Core-Shell Nanostructures," *2021 STLE Virtual Annual Meeting*, Virtual Conference, May 17-20, 2021.
5. **Fleming, R.A.**, "Dislocation Confinement in Core-Shell Nanostructures: A Molecular Dynamics Study," *47th International Conference on Metallurgical Coatings and Thin Films*, Virtual Conference, April 26-30, 2021.
6. Adawi, M. and **Fleming, R.A.**, "Development of an Instrumented Soiling Chamber for Evaluating Solar PV Coatings," *2021 NREL Virtual Photovoltaic Reliability Workshop*, February 22-26, 2021.
7. **Fleming, R.A.**, "Molecular Dynamics Simulations of Dislocation Confinement Effects in Core-Shell Nanostructures," *2020 STLE Tribology Frontiers Virtual Conference*, November 9-13, 2020.
8. Hughes, S. and **Fleming, R.A.**, "Molecular Dynamics Investigation of Nanocompression of Al/a-Si Core-Shell Nanostructures: The Effects of a-Si Shell Construction," *2020 STEM Posters at the Capitol*, Little Rock, AR, February 19, 2020.
9. **Fleming, R.A.**, Sahm, A., Sherwin, J.R., King, B.H., and Thompson, C.S., "Field Installations of a High-Performance Antireflective Coating for Solar Modules," *2019 NREL Photovoltaic Reliability Workshop*, Golden, CO, February 26-28, 2019.
10. **Fleming, R.A.**, Steck, J.G., and Zou, M., "Novel Mechanical Properties of Core-shell Nanostructures," *Materials Science & Technology (MS&T) 2018*, Columbus, OH, October 14-18, 2018.

11. **Fleming, R.A.**, Moffitt, S.L., Burton, P.D., and Schelhas, L.T., “Advanced Multifunctional Coatings for PV Glass to Reduce Soiling Losses,” *DuraMAT Fall 2018 Workshop*, Menlo Park, CA, August 28-30, 2018.
12. Moffitt, S.L., **Fleming, R.A.**, Thompson, C.S., Toney, M.F., and Schelhas, L.T., “Fundamental Characterization of Anti-Soiling Coatings for PV Glass: Application of Small-Angle X-ray Scattering,” *2018 IEEE PVSC*, Waikoloa, HI, June 10-15, 2018.
13. Steck, J.G., **Fleming, R.A.**, Goss, J.A., and Zou, M., “Fatigue Property Study of Al/a-Si Core-Shell Nanostructures by Cyclic Nanoindentation,” *STLE 73rd Annual Meeting*, Minneapolis, MN, May 20-24, 2018.
14. **Fleming, R.A.**, Pop, S.C., Moffitt, S.L., Schelhas, L.T., and Thompson, C.S., “Advanced Multifunctional Coatings for PV Glass to Reduce Soiling and PID Losses,” *2018 NREL Photovoltaic Reliability Workshop*, Golden, CO, February 27 – March 1, 2018.
15. Moffitt, S.L., Melkote, S., **Fleming, R.A.**, Thompson, C.S., Toney, M.F., and Schelhas, L.T., “Anti-Soiling Coatings for PV Glass: Understanding Functionality and Degradation Pathways,” *DuraMAT Fall 2017 Workshop*, Albuquerque, NM, November 7-8, 2017.
16. Freiburger, B., Thompson, C.S., **Fleming, R.A.**, Hutchings, D., and Pop, S.C., “High Efficiency Anti-Reflective Coating for PV Module Glass,” *2017 IEEE PVSC*, Washington, D.C., June 25-30, 2017.
17. **Fleming, R.A.** and Zou, M., “Mechanical and Tribological Properties of Novel High-Strength Nanoscale Structures,” *6th Annual World Congress on Advanced Materials*, Xi’an, China, June 14-16, 2017.
18. **Fleming, R.A.**, Freiburger, B., Thompson, C.S., Hutchings, D., and Pop, S.C., “Development of a Durable High-Performance Antireflective Glass Coating with Resistance to Particulate Soiling,” *2017 NREL Photovoltaic Reliability Workshop*, Golden, CO, February 28 – March 2, 2017.
19. **Fleming, R.A.** and Zou, M., “Friction and Adhesion Characterization of Deformation-Resistant Nanostructure-Textured Surfaces,” *2016 STLE Tribology Frontiers Conference*, Chicago, IL, November 13-15, 2016.
20. **Fleming, R.A.** and Zou, M., “Engineered Surfaces with Deformation-Resistant Core-Shell Nanostructures,” *76th Physical Electronics Conference*, Fayetteville, AR, June 20-23, 2016.
21. **Fleming, R.A.** and Zou, M., “Durable, Low Friction Engineered Surfaces Using Deformation Resistant Core-Shell Nanostructures,” *STLE 71st Annual Meeting*, Las Vegas, NV, May 15-19, 2016.
22. **Fleming, R.A.** and Zou, M., “The Effects of Core Confinement on the Mechanical Response of Al/a-Si Core-shell nanostructures,” *43rd International Conference on Metallurgical Coatings and Thin Films*, San Diego, CA, April 25-29, 2016.
23. **Fleming, R.A.** and Zou, M., “Friction and Deformation Study of Patterned Al Nanodots and Al/a-Si Core-shell Nanostructures,” *STLE 70th Annual Meeting*, Dallas, TX, May 17-21, 2015.
24. **Fleming, R.A.** and Zou, M., “Deformation Behavior in Al/a-Si Core-shell Nanostructures and Layered Thin-films,” *42nd International Conference on Metallurgical Coatings and Thin Films*, San Diego, CA, April 20-24, 2015.
25. **Fleming, R.A.** and Zou, M., “Deformation Resistance and Indentation Behavior of Al/a-Si Layered Thin-films,” *STLE 69th Annual Meeting*, Orlando, FL, May 18-22, 2014.
26. **Fleming, R.A.** and Zou, M., “Load- and Displacement-controlled Nanoindentation of Al/a-Si Core-Shell Nanostructures,” *TMS 2014 Annual Meeting*, San Diego, CA, February 16-20, 2014.
27. **Fleming, R.A.**, Royhman, D., Sukotjo, C., and Zou, M., “Surface Wetting Modifications on Titanium for Biomedical Applications,” *ABI Fall Research Symposium*, Fayetteville, AR, Oct. 23, 2012.
28. **Fleming, R.A.**, Thompson, C., and Zou, M., “Functional Surface Engineering for Surface Wetting Modifications,” *2012 NSF Engineering Research and Innovation Conference*, Boston, MA, July 9-12, 2012.
29. **Fleming, R.A.**, Alston, N., Beckford, S., and Zou, M., “Surface Engineering on Optically Transparent Materials: Extreme Surface Wettability, Anti-Fogging Behavior, and Enhanced Optical Transmittance,” *22nd National NSF EPSCoR Conference*, Coeur d’Alene, ID, October 24-27, 2011.

30. **Fleming, R.A.** and Zou, M., “Fabrication of Superhydrophilic and Superhydrophobic Surfaces on Titanium Substrates,” *38th International Conference on Metallurgical Coatings and Thin Films*, San Diego, CA, May 2-6, 2011.
31. **Fleming, R.A.** and Zou, M., “Aluminum Films with Protruding Nanoislands by Thermal Evaporation,” *38th International Conference on Metallurgical Coatings and Thin Films*, San Diego, CA, May 2-6, 2011.
32. **Fleming, R.A.** and Zou, M., “Fabrication of Stable Superhydrophilic Surfaces on Titanium Substrates,” *38th International Conference on Metallurgical Coatings and Thin Films*, San Diego, CA, May 2-6, 2011.
33. Zou, M., **Fleming, R.A.**, and Wang, H., “Friction Study of Nano-engineered Surface by Physical and Chemical Vapor Deposition,” *STLE 65th Annual Meeting*, Las Vegas, NV, May 16-20, 2010.

Patents

1. Zou, M., Thompson, C.S., and **Fleming, R.A.**, “Antireflective coating for glass applications and method of forming same,” U.S. Patent 11121267, Granted: September 14, 2021.

Invited Seminars/Webinars:

1. “Advanced Characterization, Field Performance, and Techno-Economic Considerations of an Anti-soiling Coating for PV Modules,” PVQAT Soiling Group Quarterly Webinar, May 14, 2019 (presented in collaboration with Dr. Michael Woodhouse, NREL).
2. “Technical Challenges and Opportunities in a High-Tech Start-Up,” University of Arkansas μ EP TNEWS REU Seminar, June 15, 2018.
3. “Development and Understanding of Anti-Soiling Antireflective Coatings for Solar Modules,” DuraMAT Soiling Group Monthly Webinar, August 16, 2017.
4. “Durable, Low Friction Multifunctional Engineered Surfaces Using Deformation-Resistant Core-Shell Nanostructures,” Center for Advanced Surface Engineering Monthly Seminar, March 14, 2016.

Current and Pending Awards:

1. Title: “Fundamental Studies of Soiling and Cementation of PV Cover Glass Materials: Addressing Reliability with Advanced X-ray Scattering/Spectroscopy and First Principles Modeling”
PI: Robert Fleming (Arkansas State); DOE National Lab Partners: Laura Schelhas (NREL), Vincenzo Lordi (LLNL)
Funding Agency: DOE-EPSCoR (Office of Basic Energy Sciences)
Award Amount: \$358,079
Award Period: 9/1/2020 – 8/31/2022
2. Title: “Dislocation Dynamics in Confined Volumes: Computational Modeling for Design of Advanced Functional Materials”
PI: Robert Fleming (Arkansas State)
Funding Agency: Oak Ridge Associated Universities
Award Amount: \$10,000
Award Period: 6/1/21 – 5/31/2022
3. Title: “PFI-RP: Low-friction and Durable Graphite Coatings for Reducing Energy Consumption in Conveyor Systems”
PI: Min Zou (University of Arkansas); Co-PI: Robert Fleming (Arkansas State)
Funding Agency: NSF Div. of Industrial Innovation & Partnerships
Award Amount: \$549,998 (Co-PI Share: \$123,008)
Award Status: Pending
4. Title: “MRI: Acquisition of a Nanoindenter for Materials Science and Biomaterials Research”
PI: Robert Fleming (Arkansas State); Co-PIs: Rob Shields (Arkansas State), Viswanathan Rajagopalan (NYIT), Zahid Hossain (Arkansas State), Ilwoo Seok (Arkansas State)
Funding Agency: NSF Office of Integrative Activities (OIA)

Award Amount: \$586,231

Award Status: Pending

Teaching Experience:

Arkansas State University

Sp22: ME 4573 Mechanical System Design, ENGR 3473 Fluid Mechanics

Fa21: ME 4543 Machine Design, ENGR 659V Advanced Mechanics of Materials

Su21: ME 3553 Engineering Thermodynamics II

Sp21: ME 4573 Mechanical System Design, ENGR 3443 Engineering Thermodynamics I, ENGR 3473 Fluid Mechanics, ENGR 3471 Fluid Mechanics Lab

Fa20: ME 4543 Machine Design, ENGR 3473 Fluid Mechanics, ENGR 3471 Fluid Mechanics Lab, ENGR 449V Applied Materials Science and Engineering

Sp20: ME 4573 Mechanical System Design, ENGR 3443 Engineering Thermodynamics I, ENGR 3471 Fluid Mechanics Lab

Fa19: ME 4543 Machine Design, ENGR 3471 Fluid Mechanics Lab

Awards:

- Ralph E. Powe Junior Faculty Enhancement Award from ORAU, 2021
- Edmond E. Bisson Award from STLE, 2019
- NSF Graduate Research Fellowship, 2011-2016
- Gold Poster Award at STLE Annual Meeting, 2016
- Silver Poster Award at STLE Tribology Frontiers Conference, 2016
- 2nd Place Poster Award at 76th Physical Electronics Conference, 2016
- NSF CMMI Engineering Research and Innovation Student Conference Fellowship, 2012
- NSF Summer Institute Short Course on Cancer Nanotechnology Fellowship, 2011
- Named to UIUC's List of Teachers Ranked as Excellent by their Students, 2009

Professional Capabilities:

- Extensive experience in surface engineering and surface characterization as it relates to optics, surface wetting, soiling, surface chemical analysis, experimental nanomechanics, nanotribology, etc.
- 7+ years of experience in developing, characterizing, and commercializing high-performance antireflective coatings for solar photovoltaic applications
- Expertise in computational materials science simulation using high-performance computing resources:
 - *razor*, *trestles*, and *pinnacle* at the Arkansas High-Performance Computing Center (AHPCC)
 - *grace* at the University of Arkansas for Medical Sciences
 - *stampede* at the Texas Advanced Computing Center (TACC)
 - *quartz and pascal* at Livermore Computing (LC) @ Lawrence Livermore National Lab
- Trained user of the BL1-5 beam line (small-angle X-ray scattering) at the Stanford Synchrotron Radiation Lightsource (SSRL) at the SLAC National Accelerator Laboratory

Professional Service:

- Faculty Sponsor for A-State's ASME Human Powered Vehicle Challenge (HPVC) Team
- Arkansas State University Faculty Research Awards Committee (FRAC) Chair, 2020-2021
- Reviewer for the ASME Journal of Tribology, Tribology Letters, Thin Solid Films, Journal of Materials Research, IEEE Journal of Photovoltaics, Solar Energy Materials & Solar Cells, and Journal of Adhesion Science & Technology
- Proposal Reviewer for the DOE Technology Commercialization Fund, SETO SBIR/STTR Program
- Application Reviewer for the ADHE SURF Program and NSF Fellowship Programs
- Co-chaired a working group session on PV module coatings at the 2017 DuraMAT Annual Meeting

- ASME Tribology Division Education Committee member, 2012-2016
- Mentored 14 undergraduate students through NSF REUs and other undergraduate research programs