

PROMOTION RECOMMENDATION  
The University of Michigan  
College of Engineering

John E. Foster, associate professor of nuclear engineering and radiological sciences, without tenure, Department of Nuclear Engineering and Radiological Sciences, College of Engineering, is recommended for the granting of tenure to be held with his title of associate professor of nuclear engineering and radiological sciences, Department of Nuclear Engineering and Radiological Sciences, College of Engineering.

Academic Degrees:

Ph.D. 1996 University of Michigan, Applied Physics, Ann Arbor, MI  
B.S. 1991 Jackson State University, Physics, Jackson, MS

Professional Record:

2006 -- present Associate Professor (without tenure), Department of Nuclear Engineering and Radiological Sciences, University of Michigan  
2005 -- 2006 Senior Scientist, NASA  
2003 -- 2004 Principal Investigator, NASA  
1998 -- 2003 Research Scientist, NASA  
1997 -- 1998 Research Associate, University of Wisconsin, NSF Engineering Research Center for Plasma-Aided Manufacturing, Madison, WI

Summary of Evaluation:

Teaching: Professor Foster is acknowledged by students' letters to be an excellent and caring classroom instructor. He teaches the basics of plasma science and technology, having designed problems and exam questions that foster critical thinking and synthesis of knowledge learned in class and from the textbook. These materials are permeated with examples of industrial plasmas and space plasmas, with a mix of contemporary topics, a technique which the committee strongly endorses. Professor Foster's Q1 scores range from 4.1 to 4.6 and Q2 ranging from 4.3 to 4.9. The exception was a one-time offering of a survey course for non-majors, having Q1 and Q2 of 3.8 and 3.9, which are still considered satisfactory.

Professor Foster has devoted a significant amount of out-of-class time to meet with students on individual projects and other matters. Professor Foster regularly issues study guides and conducts study sessions prior to exams, with close to 100 percent participations in these semi-formal sessions. This practice provides a chance for Professor Foster to calibrate his teaching against what students have learned. It is clear from student comments that he is willing and happy to interact deeply with them on any level to address their needs and, in the process, motivate them to higher levels of achievement.

Professor Foster is highly successful in graduate and undergraduate student supervision. He has chaired or co-chaired eight doctoral theses, two of which have been completed and whose authors are now employed at highly regarded laboratories. He has served or is serving as a member on 25 other doctoral thesis committees from within several Engineering departments. He has supervised 13 Master's projects and undergraduate major projects. This unusual level of student engagement, across multiple departments is a reflection of Professor Foster's dedication to students, and his effective communications to students of the importance of plasmas to the modern world, such as in water purification, plasma medicine or space propulsion.

Research: Professor Foster came to Michigan after spending eight years at the NASA Glenn Research Center where his research addressed the science and technology of plasma sources for electric propulsion of spacecraft. His primary focus was on development of electron cathode sources, especially using microwaves, that had high electrical efficiency and long lifetimes, both a requirement for multi-year missions to the outer planets. He also developed and applied experimental diagnostics to characterize high power plasma space propulsion systems. Since his arrival, he has broadened his research while continuing his core work in plasma propulsion. Professor Foster has established an international reputation for leadership in many aspects of electric propulsion. His current efforts are in low temperature plasmas with applications in environmental cleanup and human health care, areas in which he is breaking new ground. The expansion of his research into plasmas for environmental and health issues is well-timed and ripe for impact – and he is now showing significant progress in these areas.

Professor Foster has published extensively in the top journals in his field. He has over 40 articles in archival refereed journals and numerous refereed conference proceedings. Professor Foster has garnered over \$2M in external funding (counting only his share of multi-PI proposals). This total includes more than \$1M for his own research program, and over \$1M he has obtained for student fellowships and career development activities for programs outside his own research group, such as the Applied Physics Program and the Rackham Graduate College Bridging Program. He has a growing recognition for his entrepreneurial activities, where he produces about one invention or disclosure per year. Professor Foster has attracted Federal Small Business Innovative Research funding in collaboration with a local company that will help develop new propulsion approaches for the commercial space sector.

#### Recent and Significant Publications:

- Sommers, B., Foster, J.E., and Kushner, M.J., “Observations of electric discharge streamer propagation and capillary oscillations on the surface of air bubbles in water,” *Journal of Physics D: Applied Physics*, 44, 082001, 2011.
- Foster, J.E., Sommers, B., Weatherford, B., Yee, B., and Gupta, M.\*, “Characterization of the evolution of underwater DBD plasma jet,” *Plasma Sources Science and Technology*, 20, 034018, 2011.
- Foster, J.E., Weatherford, B., and Gillman, E., “Underwater DBD Plasma Jet,” *Plasma Sources Science and Technology*, 19, 025001, 2010.
- Nguyen, S.V.T., Foster, J.E., and Gallimore, A.D., “Operating a radio-frequency plasma source on water vapor,” *Review of Scientific Instruments*, 80, 083503, 2009.
- Mandell, M., Davis, V., Pencil, E., Patterson, M., McEwen, H., Foster, J., and Synder, J., “Modeling the NEXT Multithruster Array Test with Nascp-2k,” *IEEE Transactions on Plasma Science*, 36, 2309, 2008.
- Foster, J.E. and Gillman, E., “Magnetically enhanced inductive discharge chamber for electric propulsion applications,” *IEEE Transactions on Plasma Science*, 36, 2130, 2008.
- Hidaka, Y., Foster, J.E., Getty, W.D., Gilgenbach, R.M., and Lau, Y.Y., “Performance and analysis of an electron cyclotron resonance plasma cathode,” *Journal of Vacuum of Science and Technology A*, 25, 781, 2007.

Service: Professor Foster has performed substantial and significant service to his department, the College of Engineering, the University and to the external academic and professional community in plasma physics. Within the University and College, Professor Foster has made significant contributions to diversity. He has served as the Nuclear Engineering Department Alliance for Graduate Education Program (AGEP) representative as well as the professorate representative. AGEP is an NSF funded program administered by the Rackham Graduate College (RGC) which is directed toward increasing the number of underrepresented minorities in graduate school. With regard to external service, he is currently a member of the prestigious Plasma Science Committee of the National Research Council Board on

Physics and Astronomy. This service is particularly important at this time since there is widespread concern about the future funding levels for plasma science at DOE, NASA and NSF. Professor Foster is also a member of the IEEE Plasma Science and Applications Committee. He has acted as a proposal reviewer for DOE and NSF, and a referee for papers submitted to the main scientific journals in his field.

External Reviewers:

Reviewer A: "In my opinion his standing and reputation is excellent, comparable with any of the senior engineers from NASA...as well as the important players from academia."

Reviewer B: "Dr. Foster's enthusiasm for scientific research and creativity, has earned him great respect among his peers. His contributions to the field of electric propulsion have played a key role in advancing these technologies, and are well known at NASA...he is a prolific presenter, with a natural ability to present difficult concepts to the uninitiated in its simplest terms...Dr. Foster's research has been at the very pinnacle of his field."

Reviewer C: "His work is looking at the injection of plasma directly into the water...This is an important potential application of plasmas that shows strong potential to work...Prof. Foster and his students are making experimental measurements and interpretations that are helping to develop a more fundamental understanding of discharges in water."

Reviewer D: "Professor Foster's work in space propulsion...is exemplary. John has a reputation within the field for careful experimentation and for innovative vision in conceiving of new space propulsion concepts and technologies."

Reviewer E: "These developments point to a general trend in Prof. Foster's research: deep understanding of the fundamental science coupled with outstanding skills in developing a variety of diagnostic techniques to elucidate important physics...Beyond Prof. Foster's research excellence, I will also mention his strong service to the plasma physics community."

Reviewer F: "He has an established record of excellence in the area of plasma thruster research and is leveraging that work to move into a new field [plasma medicine] that has a great deal of promise...Finally in the area of service...Prof. Foster has begun to build a national reputation through his service on major scientific committees in the area of plasma science."

Summary of Recommendation: Professor Foster is a highly productive, internationally recognized researcher who has made significant contributions to plasma electric propulsion and is breaking ground in the newest, most high impact area of low temperature plasmas (plasma medicine and environmental applications). His teaching and advising are extremely well received by students, and his service to the University and profession are exemplary. It is with the support of the College of Engineering Executive Committee that I recommend John E. Foster for the granting of tenure in his title as associate professor of nuclear engineering and radiological sciences, Department of Nuclear Engineering and Radiological Sciences, College of Engineering.



David C. Munson, Jr.  
Robert J. Vlasic Dean of Engineering  
College of Engineering

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