

## **IEEE Magnetics Society Distinguished Lecture Departmental Seminar – Electrical and Computer Engineering**



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### **Structural Magnetostrictive Alloys: From Flexible Sensors to Energy Harvesters and Magnetically Controlled Auxetics**

**Abstract:** Novel sensors and energy harvesting transducers take advantage of the significantly expanded design space made possible by recent advances in structural magnetostrictive alloys. These alloys can be machined and welded, have high fracture toughness, and can actuate, sense, and carry load while subjected to tension, compression, and bending. The talk includes an introduction to magnetostrictive materials and transduction, and a discussion on the use of low-cost rolling and annealing methods in lieu of more costly crystal growth methods for making bulk iron-gallium (Galfenol) and iron-aluminum (Alfenol) alloys. The process of using magnetostrictive materials to convert mechanical energy into magnetic energy and then into electrical energy is explained and demonstrated using sensors and energy harvesting devices as examples. Examples of magnetostrictive devices include prototypes ranging in size from nanowire-based pressure sensors to huge structures floating in the ocean that convert wave energy into electrical power for “community-scale” energy needs. The recent discovery of a particularly unique attribute of these alloys, their auxetic behavior, will also be discussed. In both Galfenol and Alfenol, both strain and magnetic fields can produce simultaneous increases in lateral and longitudinal dimensions, with measured values of the resulting Poisson ratio being not only negative, but as low as -2.0 in some cases. Mechanical, aerospace and civil engineers should find the discussion on the use of magnetic fields to control auxetic behavior quite interesting.

**Bio:** Alison Flatau received her undergraduate degree in chemical engineering from the University of Connecticut and the M.S. and Ph.D. degrees in mechanical engineering from the University of Utah. She taught engineering mechanics at Iowa State University for eight years prior to joining the University Maryland’s Department of Aerospace Engineering in 2002. She served as the program director for the Dynamic Systems Modeling, Sensing, and Control Program at the National Science Foundation during 1998-2002 and as the associate dean of research for the University of Maryland’s Clark School of Engineering during 2009-2015. Her teaching and research interests are in the areas of smart materials and structures, with emphasis on magnetostrictive actuator and sensor technologies, from the nano- to the macro-scale. Her experience includes four years at the National Small Wind Systems Test Center (now the National Renewable Energy Laboratory) in Golden, Colorado, where she was a senior research engineer in the Wind Energy Conversion Systems Test Program. Prof. Flatau received the Clark School of Engineering’s Faculty Service Award in 2009, the Women in Aerospace (WIA) Aerospace Engineering Educator of the Year Award in 2010, the SPIE Smart Structures and Materials Lifetime Achievement Award in 2010, and the American Society of Mechanical Engineers (ASME) Adaptive Structures and Materials Systems Prize in 2013. She was a University of Maryland ADVANCE Professor in 2011-2013 and was a Dresden Fellow while on sabbatical at the Technical University of Dresden, Germany, in 2016. She became a Fellow of the ASME in 2006 and of the American Institute of Aeronautics and Astronautics (AIAA) in 2013.