Physics Colloquium
Michigan Technological University

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Room 139, Fisher Hall

Magnetorheological Materials

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Magnetorheological (MR) materials possess mechanical or rheological properties that can be controlled by magnetic fields. MR fluids, the prototypical MR materials, comprise magnetically soft particles dispersed in polar or nonpolar liquids. These particles align to form chains or more complex structures when a magnetic field is applied, rapidly and reversibly transforming the fluid into a weak viscoelastic solid. This remarkable phenomenon is caused by strong magnetic dipole-dipole attractive forces between the particles. Related materials include magnetic powders, in which the magnetic particles are dispersed in air, and MR elastomers, in which the particles are embedded in elastic solids. The fascinating behavior of these materials, coupled with their many potential uses in the automobile and elsewhere, has motivated considerable scientific and technological effort and progress over the last decade.

In this seminar, I will describe some of the measurements, models, and proof-of-concept hardware we have developed toward implementing this technology. I will focus on the key role of dipole interactions and magnetic nonlinearity in determining the performance of MR materials. Finally, I will spell out some of the open scientific and technical challenges in this field.

John M. Ginder is a Technical Leader in Research and Advanced Engineering at the Ford Motor Company in Dearborn, Michigan. A native of Ohio, he received a B.S. degree (*magna cum laude*) in Physics from Rensselaer Polytechnic Institute in 1983. At The Ohio State University he studied the magnetic and optical properties of conducting polymers, and there received a M.S. in 1985 and a Ph.D. in 1988, both in Physics. After two years as a Postdoctoral Research Associate at Ohio State, he joined Ford. Much of Dr. Ginder's work at Ford has focused on field-controllable or 'smart' fluids. In addition to developing several pioneering experimental and numerical approaches to understand the properties of 'smart' fluids, he has also led the development of a number of automotive applications of these materials. His current research interests include automotive applications of nanomaterials, 'smart' materials, and electromagnetic phenomena. He is an author or co-author of over sixty papers, co-inventor of greater than twenty patents, and has presented over fifty invited talks during his career.