Giant Magnetostriction

Advanced

Here are a few "clippings" concerning giant magnetostriction. (Emphasizes are mine)

- Announcement of a **NATO** conference; June **2000**

The phenomenon of *magnetostriction* was discovered more than 150 years ago (Joule J.P. Philosophical Magazine, 1847, **30,** p.76). Since that time there has been both study of the basic science, and application in such areas as the generators of sound, magnetoacoustic transformers, actuators for opto-electronic systems, devices for non-destructive control and remote detection and ranging. The recent development of modern technologies, such as microfabrication, and materials, such as rare earth based bulk materials and magnetic thin films, has produced new opportunities for the study and application of magnetostriction. Thus, *discovery of giant magnetostriction*, enables one, in particular, to generate ultrasound and extend the usage of the non-destructive control techniques; development of *cryogenic technologies* gives new insight to the forced magnetostriction, namely to its irreversible component, related to *magnetization reversal* and *thermoactivated processes* , which are involved in displacement of the *domain walls and flux lines*, i.e. stability of magnetic and superconducting devices, as well as to the giant magnetostriction in *rare-earth-magnets* (up to 10^{-2}). The new field of the interest in magnetostriction as the strain derivative of *magnetic anisotropy*, is relevant to *magnetic recording industry*, particularly as recorded densities go beyond 20 Gbits/in^2. As physical dimensions of devices are reduced the surface area to volume ratio increases, and surface anisotropy (magnetostriction) effects may become significant in terms of ultimate switching speeds or noise floor. Miniaturisation within the sensor/actuator sector also may invoke such complications, and also now make magnetostrictive materials competitive with piezoelectric materials. There has been a resurgence of interest in perovskite materials, particularly for their outstanding magnetoresistive properties. The fundamental mechanisms driving the observed effects are still being elucidated, but lattice distortions (Jahn-Teller) and significant magnetostrictions appear to play a part. There is an urgent need for coherent studies in this area.

Magnetic field induced *giant magnetostriction* has recently been discovered in high-temperature superconductors.The magnetoelastic strains may limit technical applications of this important group of materials.

Spread of the novel experimental techniques like *magnetic resonances, neutron scattering, modern X-ray facilities* to magnetostriction examination, allows high resolution *structural studies* of magnetostriction and the differentiation of its surface and bulk components. It is timely to review and explore the various possibilities offered here, and attempt to co-ordinate the use of large scale facilities to maximise the scientific output.

The goals of the proposed ASI were delivery of lectures on new achievements and discussion of the listed potentials for the study and application of magnetostriction study among experts from the different branches of science and industry, presenting the leading teams of the West and Eastern Europe. It is hoped that a more co-ordinated and focussed approach at both the level of fundamental science and demonstrator applications, moved the subject on significantly. Wide dissemination of the meeting via publications will be an important outcome. The recent opening up of Eastern Europe makes such a meeting practical, as before much expertise lay beyond the reach of western scientists. This ASI was the first forum on modern trends in magnetostriction study and application. Only a meeting of this kind, supported by NATO, allowed us to gather the worldwide acknowledged specialists in the related fields, capable to promote the solution of the existing problems and identify the future prospects.

- Dec. **2000** News from Ames Lab - Iowa State University

Giant Magnetostrictive Materials
Just about everything you ever wanted to know about magnetostriction is covered in a new book by Goran Engdahl entitled Handbook of Giant Magnetostrictive Materials.
The book is a fairly thorough treatment of giant magnetostrictive materials, from basic theory and physics to applications. The book contains six chapters and four appendices. The first chapter is entitled "Physics of Giant Magnetostriction." It covers a wide range of topics from the physical origins of giant magnetostriction to manufacturing processes. Stops along the way include metallurgy and microstructure, crystallography, atomic and magnetic force microscopy images, designing materials, crystalline rare earth alloys, applications, and, of course, TERFENOL-D, among other materials. This chapter includes 85 figures, 50 equations, and 13 tables, all of which serve as excellent illustrative guides to understanding the subject.
The second chapter is devoted to modeling giant magnetostrictive materials. Linear models, finite element modeling, and nonlinear modeling are discussed in detail. Explanations and illustrations of stress and strain, coupling, equivalent circuits, resonance, wave propagation, eddy currents, hysteresis, among others, are included. As is expected, a large number of equations are necessary to explain the topics adequately, and over 230 equations are used throughout the chapter, accompanied by 38 figures.
Chapter 3 covers magnetostrictive design and contains discussions of magnetic, electrical, mechanical, electromechanical, and thermal design. Also included are physical data of TERFENOL-D, magnetic and mechanical operation ranges, 38 figures, and 54 equations.

Two methods of actuator characterization using magnetostrictive materials are presented in Chapter 4. The two methods are time domain methods and frequency domain methods. The discussion is accompanied by 14 figures, 23 equations, and one table.
Device applications are covered in Chapter 5, with emphases on sound and vibration sources, vibrational control, direct and indirect motional control, and materials processing. The final chapter discusses the materials, fabrication, and application of giant magnetostrictive thin films.