



PROGRAM

10:45 - 11:00 a.m. Tea, Coffee and Treats

11:00 - 11:45 p.m. Lecture (typical)

11:45 - 12:00 p.m. Q&A and Discussion

ABSTRACT

Shape Memory Alloys (SMAs) are unique class of structural and functional materials because of their unique ability to change their shape upon the application of external effects such as stress, heat, and magnetic field and recoverability of the shape change upon removal of these effects. From a materials engineering point of view, these alloys are important, especially for teaching metallurgy and increasing the excitement among students towards materials design and selection, since they allow covering basic scientific issues from diffusional and diffusionless phase transformations to strengthening mechanisms and from thermodynamics and kinetics to functional properties in a single material system such as Nickel-Titanium while also serving as an exceptional demonstration tool for students. Even though, they were invented in 60's, in the last ten years, there is an ever increasing interest on several aspects of SMAs pushing its limits for new applications, for example in defense, space, and biomedical applications, in MEMS and NEMS in the form of thin films, nanowires, porous state etc. which has in turn led to the design of new alloys such as magnetic SMAs, high temperature SMAs, Ni free biomedical SMAs, and inexpensive iron-based SMAs.

In this talk, current research activities at Texas A&M University in magnetic SMAs, high temperature SMAs, Ni-free SMAs and developing inexpensive SMAs will be presented. Recent exciting findings in magnetic SMAs will be discussed. Magnetic shape memory alloys (MSMAs) have attracted recent interest because of the ability to obtain one order of magnitude higher magnetic field induced strain than magnetostrictive materials and few orders of magnitude faster dynamic response than conventional SMAs. They can also be used for sensing and passive power generation due to significant changes in magnetization upon the application of fluctuating mechanical forces or displacements making them truly multifunctional. Previous studies have mainly focused on field-induced martensite variant reorientation being the governing mechanism for the magnetic field-induced shape change, especially in NiMnGa alloys, which has resulted in low actuation stress levels. We have recently shown that field-induced phase transformation is possible in some new MSMAs under low field magnitudes and it can be reversible depending on the magnitudes of stress hysteresis, magnetocrystalline anisotropy and saturation magnetization.

SEMINAR TITLE

Shape Memory Alloys: Current Status and Future Prospect for Research

SEMINAR SPEAKER

Professor Ibrahim Karaman

Department of Mechanical Engineering, Texas
A&M University

Utilizing field-induced phase transformation, more than one order of magnitude increase in actuation stress can be achieved. An extensive experimental program is undertaken on NiMnGa and NiMnCoIn single crystals in quest for identifying physical and microstructural parameters critical in field-induced phase transformation phenomena. A thermodynamical framework is constructed and will be discussed to identify the effects of magnetic field on martensitic phase transformations. Using the thermodynamical model, guidelines to increase the actuation stress levels and possible future directions for research on magnetic shape memory alloys will be presented.

Examples of current efforts in K-12 and undergraduate education at Texas A&M University utilizing these alloys will also be given.

Dr. Ibrahim Karaman

Ibrahim Karaman received his Ph.D. from University of Illinois at Urbana-Champaign in 2000. He joined the faculty of Department of Mechanical Engineering at Texas A&M University in 2000. Currently, he is an Associate Professor in the same department. He is also a member of the Faculty of Materials Science and Engineering Graduate Program. His main research interests are processing-microstructure-mechanical/functional property relationships in metallic materials including 1) ultrafine and nanocrystalline materials, 2) conventional, high temperature and magnetic shape memory alloys, and 3) bulk metallic glasses and composites; micro-mechanical constitutive modeling of crystal plasticity; twinning and martensitic phase transformation in metallic materials, magnetic, thermal and mechanical activation of martensitic phase transformation. Dr. Karaman received several national and international awards including the NSF CAREER Award in 2002, ONR Young Investigator Award in 2005, The Robert Lansing Hardy Award from The Minerals, Metals and Materials Society in 2005, and an Honorable Mention for the 2007 Early Career Faculty Fellow Award from The Minerals, Metals and Materials Society in 2007. The Robert Lansing Hardy Award recognizes "outstanding promise for a successful career in the broad field of metallurgy by a metallurgist under the age of 35" and one award is given per year. He is an author or co-author on 65 refereed journal articles.

