Available online at www.sciencedirect.com
SCIENCE DIRECT®
Scripta Materialia 53 (2005) 381–382
Scripta MATERIALIA
www.actamat-journals.com

Preface to viewpoint set on: $L1_0$ phases for permanent magnet and recording applications

The discovery of the extraordinary magnetic properties of the $L1_0$-class of permanent magnet materials dates back to the 1930s. The classic Co–Pt alloy was discovered by Jellinghaus [1] in 1936 and attractive magnetic properties were readily tailored through heat treatment [2]. Interest in these magnetic materials has persisted for over a half-century. The family of $L1_0$ magnetic alloys is most prominently represented by the Co–Pt, Fe–Pt, Fe–Pd and Mn–Al binary systems in which the tetragonal $L1_0$ derives from a high temperature close-packed phase in the solid state. In the Co–Pt, Fe–Pt and Fe–Pd alloy systems the $L1_0$ phase is a stable ordered phase and a crystallographic derivative of a parent face-centered cubic disordered solid solution. In the Mn–Al system the $L1_0$ phase is metastable forming within a hexagonal parent phase. Carbon additions are made judiciously to stabilize the metastable phase with respect to the more stable phases in the alloy system. The resultant tetragonal $L1_0$ intermetallic phases (CoPt, FePt, FePd and MnAl) exhibit uniaxial magnetocrystalline anisotropies in the range $K_1 = 10^7$–10^8 ergs cm^3 with an "easy" *c*-axis. Although the Co–Pt permanent magnet alloys were shown to have energy products in excess of 20–25 MGOe and to be highly ductile and corrosion resistant, these expensive materials only found application in certain high quality specialized instruments, hearing aids and motors for watches.The Co–Pt and first cousin Fe–Pt and Fe–Pd alloys were relegated to specialized applications and/or scientific interest. The Mn–Al–C permanent magnet materials did receive some attention from a commercial point of view over the past three decades for certain devices and magnetic circuits because of their high energy product and low density, good machineability and mechanical strength and low cost. However, processing problems have limited their development.Over the past decade there has been an explosion of interest in the $L1_0$ intermetallic phases and their associated magnetic properties for thin film devices, MEMS/NEMS, futuristic magnetic recording, magneto-optics, spintronics and dental and medical applications. The extraordinary properties of the $L1_0$ phases in nanosize configurations including self-organized magnetic arrays (SOMA) have called attention to novel applications in a myriad of assemblies [3–5].

Because of an expanding world-wide focus on the $L1_0$ and related phases in numerous laboratories and universities over the past decade, an international conference "$L1_0$ Ordered Intermetallic and Related Phases for Permanent Magnet and Recording Applications" was held August 15–20, 2004 at the Copper Mountain Resort and Conference Center, Copper Mountain, Colorado. The conference was coordinated by Engineering Conferences International (ECI). Approximately 70 participants from around the world attended and this compilation of papers derives from the symposium including some papers which were not not presented at the conference. The intent of these contributions is to provide a critical update regarding current research in the field and to focus on major challenges and opportunities in the area for advancing the scientific and technical understanding of these unique magnetic materials. The Viewpoint Set on $L1_0$ Intermetallic and Related Phases for Permanent Magnet and Recording Applications was coordinated based on this conference and original papers including thin film, fine-particle and bulk behavior are also included in this Special Issue. The papers presented in this issue provide an excellent mixture of theoretical and experimental approaches including computer simulations. Some interesting results related to magnetization reversal mechanisms were discussed as well as fundamental questions regarding order–disorder behavior in nanosized thermodynamic systems. Also, some ingenious synthesis and processing methods were described. Importantly, these deliberations show that numerous basic issues in $L1_0$ magnetism and the relationships of structure–properties-processing remain to be solved before these materials reach their fullest potential techno-

1359-6462/$ - see front matter
doi:10.1016/j.scriptamat.2005.04.043

logically and that this field represents a marvelous context for doing important science in a technologically rich area.

References

[1] Jellinghaus W. Z Tech Phys 1936;17:33.
[2] Newkirk JB, Geisler AH, Martin DL, Smoluchowski R. Trans AIME, J Metals 1950;188:1249.
[3] Cebollada A, Farrow RFC, Torey MF. Structure and magnetic properties of chemically ordered magnetic binary alloys in thin film form. In: Nalwa HS, editor. Magn Nanostruct. American Scientific Publishers; 2003. p. 93 [chapter 3].
[4] Weller D, Moser A, Folks L, Best ME, Lee W, Torey MF, et al. IEEE Trans Mag 2000;36:10.
[5] Vlasova NL, Kandaurova GS, Shchegolva NN. Fiz Met Metall 2000;90:31;
J Magn Magn Mater 2000;222:138.

Michael McHenry
Carnegie Mellon University
Materials Science and Engineering
243 Roberts Eng. Hall, 5000 Forb
Pittsburgh
USA
Tel.: +1 41 22682703; fax: +1 4122683113
E-mail address: mm7g@andrew.cmu.edu

William A. Soffa
University of Virginia
Department of Materials Science and Engineering
Charlottesville, VA 22904
USA
Tel.: +1 434 243 2532
E-mail address: was2n@virginia.edu

Available online 31 May 2005