Rare-earth Information Center INSIGHT

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Competition Grows for RE Magneto-Optic Disks

Rare earth based magneto-optic materials (primarily Gd or Tb - Fe or Co amorphous films) are being utilized as data storage media because of their high data storage densities [see **RIC Insight, 2**, [10] (October 1, 1989), **4**, [7] (July 1, 1991), **4**, [12] (December 1, 1991) and **6**, [2] (February 1, 1993)]. A new threat to this market has developed. Scientists at IBM's Almaden Research Center in San Jose, California report that they have made the most sensitive sensor for detecting computer data on magnetic hard disks. This new design will allow a twenty-fold increase in data storage in these disk-drive products over what is possible today by the year 2000. The new sensor is known as a "spin valve" head, and it makes use of the giant magnetoresistive (GMR) effect discovered about eight years ago. The spin valve is a thin film sandwich and consists of cobalt and a nickel-iron alloy separated by a copper (nonmagnetic) layer. The magnetic orientation of the cobalt layer is fixed, but that of the nickel-iron alloy is free to rotate in response to a magnetic field. When the magnetic moment orientations of the two magnetic layers are parallel, the resistance of the sandwich is at a minimum, and when they are antiparallel there is a large resistance. The design of the spin valve is such that the electrical resistance drops in response to the small magnetic fields produced by the micro-magnetic spots on the disk. This effect generates a signal when the read head's electrical resistance changes in response to the magnetic fields of the encoded information spots. The IBM spin valve is reported to be five times more sensitive than today's best commercially available disk-drive sensor.

This new development, however, may not be all that bad. As noted two issues ago [**RIC Insight, 7**, [6] (June 1, 1994)], a super giant magnetoresistance effect had been discovered in a lanthanide material — a La-Ca-Mn-O film. The GMR effect in this lanthanide film is 1000 times larger than that in the best GMR effect material known just a few months ago. This larger GMR effect may allow even higher data storage density, but it is unlikely to be a 1000-fold increase.

Improved Critical Current Densities in RE High T_c Superconductors

Japanese scientists at the International Superconductivity Technology Center, Minato-ku, Tokyo, headed by M. Murakami, report that $RBa_2Cu_3O_{7-x}$ (123) superconductors, where R = Nd or Sm, have higher critical current densities than those of melt processed $YBa_2Cu_3O_{7-x}$ containing fine inclusions of Y_2BaCuO_5. The R123 superconductors, where R is a light, large size lanthanide, have been known to have low superconducting transitions (T_c) because the large lanthanide ions substitute for Ba. Murakami *et al.* [**Jpn. J. Appl. Phys. 33**, L715-L717 (1994)] found that this substitution can be suppressed by melt processing the R123 in a reduced oxygen

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atmosphere, and the resulting materials Nd123 and Sm123 have T_c's near 95K. Furthermore, they find that they have good flux pinning in the R123 phase because of finely dispersed $(Ba_{1-x}R_x)_2Cu_3O_y$ phase in the R123 matrix. They find a critical current density of 2×10^4 A/cm^2 at 77K and an applied magnetic field of 2T, which is twice as high as the Y123 containing Y_2BaCuO_5 inclusions. The magnetic field was applied parallel to the c-axis of the sample.

Treibacher Consolidates RE Activities

Treibacher Chemische Werke AG (Treibach, Austria), which produces a wide variety of rare earth products, has reorganized their rare earth activities. Prior to mid-August, different departments were responsible for the production and sales of rare earth metals and alloys, and of rare earth compounds. But as of August 16, a new subsidiary, Treibacher Auermet, has been given the responsibility for all of the Treibacher rare earth activities. These include inorganic compounds, polishing powders, metals, mischmetal, flints and hydrogen storage alloys. The managing directors of this subsidiary are Drs. Otto Bohunovsky and Alexander Bouvier.

Fifth Family of Permanent Magnets?

It appears that a fifth family of rare earth iron/cobalt permanent magnet materials has been discovered in addition to the well known RCo_5-R_2Co_{17}, $Nd_2Fe_{14}B$, $R(Fe,M)_{12}$ and $R_2Fe_{17}N_x$ families. Initially the composition of this family of compounds was thought to be $R_2(Fe,Ti)_{19}$ [S. J. Collocott *et al.*, {CSIRO, Appl. Phys., Lindfield, Australia and Australian Inst. Nucl. Sci. & Eng., Lucas Heights, Australia} **Proc. 7th Intern. Sym. Magn. Anisotropy Coercivity Rare-Earth Trans. Metal Alloys**, pp. 437-444, Rare-earth Information Center, IPRT, Iowa State University, Ames, IA (1992) and C. D. Fuerst *et al.,* {General Motors NAO Res. & Dev. Ct., Warren, Mich., USA)} **J. Magn. Magn. Mater. 129**, L115-L119 (1994)] but a detailed crystallographic study indicated that the correct chemical formula was $R_3(Fe_{1-x}Ti_x)_{29}$, where $0.04 \leq x \leq 0.06$ [H.-S. Li *et al.*, {Univ. New South Wales, Kensington; Australian Nucl. Sci. & Tech. Organ., Lucas Heights; Univ. Tech. Sydney; CSIRO, Appl. Phys., Lindfield, all from Australia} **Solid State Comm. 90**, 487-492 (1994)]. The structure of this phase is monoclinic, is related to the $CaCu_5$ structure, and is an intermediate structure between the well known rhombohedral Th_2Zn_{17} and tetragonal $ThMn_{12}$ phases. These authors have found this structure for the light lanthanides La-Gd. The University of New South Wales, Australian authors have joined forces with two Chinese groups (Magnetism Laboratory, Institute of Physics, Chinese Academy of Sciences, Beijing, and San Huan Research Laboratory, Chinese Academy of Sciences, Beijing) and developed a new interstitial nitride phase based on the $R_3(Fe,Ti)_{29}$ parent, which has good permanent magnet properties approaching those of $Sm_2Fe_{17}N_y$. The nitride phase, $Sm_3(Fe_{0.933}Ti_{0.067})_{29}N_5$, was formed by arc-melting the component metals, heat treating, pulverizing into a powder, and finally nitriding. This nitride has a Curie temperature of 750K, a remanence of 1.04T, an intrinsic coercivity of 0.83T, an isotropic field of 12.8T and a $(BH)_{max}$ energy product of 105 kJ/m^3 (13 MGOe) at 293 K. These results were reported by B.-P. Hu *et al.,* **J. Phys. Condens. Matter 6**, L197-L200 (1994) and by F.-M. Yang *et al.,* **J. Appl. Phys. 76**, 1971-1973 (1994).

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