Rare-Earth Information Center INSIGHT

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New Permanent Magnetic Alloy Manufacturer

The Institute for Physical Research and Technology (IPRT) of Iowa State University (ISU) and Edge Technologies, Inc., Ames, Iowa, announced the formation of a new business venture which resulted from research conducted at the Ames Laboratory, a member of ISU's IPRT. Ames Specialty Metals, a division of Edge Technologies, has been licensed by ISU to produce permanent magnet alloy materials by a thermite reduction process. The initial research on the reduction of a mixture of neodymium and iron fluorides by calcium in a sealed iron retort was carried out at the U.S. Department of Energy's Ames Laboratory. The patented process was scaled up through the pilot plant stage under the auspices of another member of the IPRT consortia - the Center for Advanced Technology Development (CATD) before it was acquired by Edge Technologies. The thermite reduction process is stated to have "advantages in cost, corrosion-resistance, and simplicity of manufacturing" over the conventional processes used in industry today.

Magneto-Optic Storage Systems

Magneto-optic discs* for storage of information using amorphous rare earth (Gd and Tb) - transition metal (Fe and Co) alloys have become a commercial reality during the past year. The initial use for these devices is for personal computers and computer work stations. The amorphous alloy, magneto-optic discs can store 15 to 50 times more information (bit densities of $\sim 10^8/cm^2$ have been achieved) than the conventional magnetic hard disk* drives, however mean access time is about twice as slow: 30 to 50 msec for the magneto-optic disc vs. 10 to 20 msec for the magnetic hard disk. The other major advantage is that the near contact head to disk spacings are not required in the magneto-optic devices. The use of highly focused laser beams allows for the high storage density. Storage discs are said to be available from Sony, Canon, and Sharp, and several others are reported to be ready to introduce their EDRAW (erasable direct read after write) memory discs in the near future. The latter include Eastman Kodak, Hitachi, Mentor, Olympus, Pinnacle, Sieko, Sumitomo Electronics, Sumitomo Metal Mining, and Toshiba. Tests have shown that these EDRAW discs would be stable for five years when stored at 50°C and that less than a 10% change in the stable domain size occurred after 10^{10} write/erase cycles.

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*The spelling is "disc" in the optical technologies and "disk" in the magnetic technologies.

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The alloy in current use is $Tb_{25}(Fe_{0.9}Co_{0.1})_{75}$, and films 500 to 2000Å thick are prepared by either RF or DC sputtering. This film is then coated by a transparent thin film ceramic, such as AlN, Y_2O_3 or Si_3N_4 to protect the magneto-optic film from oxidation and/or corrosion and also abrasion. The next generation material will contain neodymium, replacing some of the terbium, because the neodymium alloy has a higher Kerr rotation at long wave length (~400nm). The sputtering is usually done from alloy targets which have been prepared by powder metallurgical processes, rather than from castings, because the latter are generally too brittle. One major problem is that the sputtering targets contain too much oxygen from the rare earth metals. Better rare earth metals (i.e. those with lower oxygen contents) would greatly aid in expanding this market.

This could be a sizable and growing market for the rare earth metals, especially if the EDRAW discs are used in the home entertainment market, such as CD's and to replace magnetic tapes currently used in cassettes and VCR's. It is, however, quite possible that these amorphous alloys may be replaced by new materials before such markets have been fully developed. Researchers are currently looking at garnets (essentially free of rare earths) for magneto-optic storage materials. The garnets are reported to have larger Kerr rotations and better stability. One of the problems with garnets, however, is that there are defects in epitaxially grown garnet layers which are nearly impossible to get rid of and this may hinder their development as viable magneto-optic materials. In the near and intermediate term things look good for the rare earths.

$R(Fe,M)_{12}$ Type Magnets

Rapid progress is being made on $R(Fe,M)_{12}$ class of permanent magnets. Samarium compounds have been found to have high magnetic anisotropies, the largest known to date is 90 kOe for $Sm(Fe,Mo)_{12}$, which is larger than the anisotropy in Nd-Fe-B permanent magnets. Singleton, et al. [Appl. Phys. Lett. 54, 1934 (1989)] have studied $Sm(Fe,M)_{12}$ alloys with M = Ti, V, Al, Cu, Ga and Si, and some alloys containing additional small amounts of boron and/or carbon. The as melt-spun alloys are magnetically soft, but high coercivities are developed when the alloys are heat treated between 750 to 1050°C. The highest coercivity was found to be 7.7 kOe for $Sm_{10}Fe_{80}Ti_{7.5}B_{2.5}$ (a two phase alloy containing the 1:12 phase plus an Fe-rich phase). This high coercivity value is also higher than that found in the Nd-Fe-B magnets. It appears more and more likely that these $R(Fe,M)_{12}$ materials will be the third type of rare earth permanent magnet materials, along with the RCo_5-R_2Co_{17} and Nd-Fe-B materials, to become a commercial reality, and conceivably they could replace a good portion of the Nd-Fe-B share of the permanent magnet market.

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