Rare-earth Information Center

Insight

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Volume 9 December 1, 1996 No. 12

Ultrahigh-Density Information-Storage Materials

Certainly one of the defining issues of technology today is that of information storage. Without the tremendous advances in information-storage density, which have been made within the past 40 years, the potential of integrated circuit technology would not have been realized. From a personal perspective, twelve years ago, I purchased a computer with a 5MB hard drive which was very impressive for the time. Last spring, the RIC bought a medium level PC with an "adequate" 2.5 GB drive. The simple truth is that the ability to process large amounts of data requires the rapid storage and retrieval of data. The materials aspects of this data storage are the subject of a series of papers in the September issue of the *MRS Bulletin*. The issue includes an overview by guest editor, M.H. Kryder, and six papers covering materials for both heads and media. Both magnetic and non-magnetic materials are covered. Rare earth materials are well represented in this field. As the requirement for more sensitive read heads grows, colossal magnetoresistive materials, such as $La_{0.67}Ca_{0.33}MnO_{3+\delta}$, are attractive for these applications. As bit size continues to decrease, the superparamagnetic limit is approached. High anisotropy materials, such as SmCo, will be required as media. Magneto-optic materials are already based on amorphous REFeCo films. Holographic-data-storage materials, which have been discussed in previous issues of this newsletter, are a means of using the frequency domain to store multiple bits at the same physical location. Some of the interesting materials for this application also contain rare earths. Putting aside for a moment our rare earth orientation, this series of papers brings an interesting insight into an area that is increasingly effecting our lives.

Photorefractive Grating Formation

A single crystal of $La_3Ga_5SiO_{14}$:Pr^{3+} has been used in the production of a photorefractive grating by C. Dam-Hansen *et. al.* {*Appl. Phys. Lett.*, **69**, [14] 2003-5 (1996)}. The refractive index grating formation and erasure were achieved using two linearly polarized laser beams symmetrically incident about the normal to the XY plane of the crystal. The interference of the two laser beams combined with the photovoltaic effect results in the development of a space-charge field within the crystal. The electro-optic effect then produces a refractive index grating. The grating was measured using a much weaker laser beam at a longer wavelength.

High-Temperature Superconducting Tapes

Ten years ago, high-temperature superconductors were discovered and glowing predictions about the impact of the discovery on technology fueled a tremendous amount of research in the area. Two severe problems were quickly identified. First, the materials were highly anisotropic. As a result, current carrying wires and tapes must have a high degree of texture and have very clean grain boundaries. Second, the Bi-Sr-Ca-Cu-O based materials, which were easy to texture, were limited by extremely poor flux pinning which results in a loss of zero resistance behavior for modest currents at temperatures much above 35K. The $REBa_2Cu_3O_7$ materials do not suffer from this limitation but it has been demonstrated

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that biaxially textured material is required to overcome the grain boundary problem. This has been extraordinarily hard to achieve. If a suitably textured substrate can be produced, the required texture may be obtained. A number of competing processes are being developed, and recently, D. P. Norton *et. al.* {*Science*, **274**, 755-7 (1996)} have reported 700,000 amperes per square centimeter at 77K in 1.5 μm thick films of $YBa_2Cu_3O_7$ (Y123) grown by the RABiTS process. RABiTS (rolling-assisted biaxially textured substrate) uses well known metallurgical techniques to produce a highly oriented Ni foil substrate. Since Ni can substitute for Cu in Y123, a CeO_2 buffer layer is deposited using pulsed laser deposition (PLD). This layer is epitaxial to the Ni; PLD is then used to produce the Y123 film. While the oriented films were produced by PLD, other commercial processes, such a metal-organic chemical vapor deposition (MOCVD), should also give good results. Given the fact that textured metals, such as grain oriented Si steel, are commercially produced in large quantities and that numerous possibilities for the deposition of the films exist, this may be a commercially viable process for producing conductors which carry large currents at 77K.

Vortex -lattice melting in $YBa_2Cu_3O_7$

As mentioned above, the problem of flux pinning has kept high temperature superconductors from meeting the grand expectations of ten years ago. In conventional superconductors, the magnetic vortices form a ridge lattice so that pinning the vortices is simply a case of restraining the lattice as a whole. It has long been hypothesized that in high-temperature superconductors the flux lattice melts into a vortex liquid so that the problem is now the equivalent of trying to carry water in a sieve. This picture has been debated for years and has only become generally accepted as the weight of experimental evidence has accumulated in its favor. Recently, A. Schilling *et. al.* {*Nature*, **382**, 791-3 (1996)} have demonstrated that the melting is a first-order phase transition by measuring the latent heat of vortex-lattice melting in an untwinned $YBa_2Cu_3O_7$ crystal. The measurement required extreme care to measure a 3.3mg single crystal.

Use of NdOCl in the Production of Magnesium

Magnesium is the lightest structural metal but due to the cost of production, it is not extensively used in mass applications. A recent article by R. A. Sharma {*JOM*, **48**, [10], 39-43 (1996)} describes a new process proposed for the production of Mg electrolytically. The process uses MgO as a feed in an electrolysis cell for producing magnesium and CO_2 . The process takes advantage of a eutectic in the $MgCl_2$ - NdOCl system which is used as the molten electrolyte. While the paper is based on Nd, it is expected that other rare earth elements may be used. In comparing with the production of Al, the author claims that the proposed electrolyte is less corrosive and the operating temperature is ~250°C lower resulting in an energy consumption per kilogram which is lower than that of standard Al production, which could theoretically lower production costs.

Company Notes

Advanced Material Resources Ltd. has announced that its two joint venture production facilities in China were each awarded ISO 9002 certification. AMR states that it is the first rare earth producer in China to receive international ISO 9002 certification.

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