Rare-earth Information Center INSIGHT

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East/West European Magnetic Materials Conference Alert

A few days ago we received an announcement concerning an East/West European Magnetic Materials Conference to be held on March 22-23, 1993 in Budapest, Hungary. This information arrived too late to be of any practical use to most scientists, engineers and technical managers for inclusion in the March 1993 issue of the **RIC News** because most of our subscribers will not receive their copy much before the actual Conference date. The major topics of the Conference include NdFeB and other rare earth magnets, future permanent magnet use in motors and automobiles, a review of the East European magnet industry, availability of rare earths, cobalt and nickel from the Commonwealth of Independent States (CIS), and import/export/trading. An optional plant trip scheduled for March 24 supplements this Conference with visits to nearby magnetic materials and loudspeaker manufacturing plants. For more information contact: Kathy Barnett, Intertech Conferences, 170 U.S. Route One, Portland, Maine 04105, phone: 207-781-9800 and fax: 207-781-2150.

Magnetic Recording - Future Trends

In the past few months two brief overviews on magnetic recording and the future directions in this field were presented by M. H. Kryder (Data Storage Systems Center, Carnegie Mellon University, Pittsburgh, PA) and S. Watanabe (Sony Research Center, Sony Corp., Yokohama, Japan). Magnetic recording technology has been utilized for data storage for computer technology for over 35 years and during that time the data storage density has increased by four orders of magnitude to about 0.3 Gbit/cm^2. But the technology is still at least four orders of magnitude away from the fundamental limits, so there is a lot of room for improvements and growth in this field. Although magnetic recording dominates the data storage industry today, magneto-optic technology is expected to play an increasingly larger role in the future, especially as a removable storage medium for large files of data involving images and multimedia. By the turn of the century storage densities will be 1 Gbit/cm^2. With this kind of density, a postage stamp-size cassette will be able to store a full hour of a digitalized and band-compressed high definition television program. Presently lanthanide (Gd or Tb) transition metal (Fe or Co or both) amorphous films are used [see **RIC Insight, 2,** [10], (October 1989), **4**, [7], (July 1991), and **4**, [12], (December 1991)] but as the drive toward high storage densities proceeds, these materials are likely to be supplanted by other substances. This change is still a few years away. The most likely candidates to replace the lanthanide-transition metal films are the synthetic Pt/Co or Pd/Co multilayer superlattice films and single crystal garnet films grown on single crystal gadolinium-gallium garnets (GGG) substrates (see following story). But other materials, which have giant magneto-optic Kerr angles (9°), about an order of magnitude larger than those of the lanthanide-

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transition metal amorphous films, may replace all of the above materials. The giant magneto-optic effects were found in some uranium and cerium compounds, but their low Curie temperature (200 K or less) severely limit their utilization for this application. M. H. Kryder's paper appeared in **Thin Solid Films, 216**, 174 (1992), while the one by S. Watanabe was published in **Meas. Sci. Technol., 3**, 1211 (1992).

Transparent Magneto-optic Materials

The state-of-the-art of the use of transparent magneto-optical materials in isolators, circulators, switches and field sensors has been reviewed by R. Wolfe [**Thin Solid Films, 216**, 184 (1992)]. The current front runners are bismuth-doped rare earth iron garnet films which are a few microns thick and have been grown by liquid phase epitaxy on single crystal gadolinium gallium garnet substrates. These materials are similar to those which were developed for magnetic bubble memories, which had uniaxial magnetic anisotropy. The latest materials, however, have a planar anisotropy. The most important attribute of these bismuth-doped yttrium-iron garnet films is their remarkable transparency at infrared wavelengths and a large Faraday rotation at 1.3 and 1.55 μm. The yttrium-iron garnet films are grown from a supersaturated flux based on lead oxide at 900°C. Gallium and aluminum are added in place of some of the iron to lower the magnetic moment, while bismuth is substituted for some of the yttrium to increase the Faraday rotation. The advantages of these thin films over bulk single crystals or thick films are the lower bias field requirements, the elimination of the need for lenses and of difficult alignment procedures, and the compatibility with integrated optics. The major disadvantage is the optical birefringence inherent in thin films, which interferes with the Faraday effect, and must be minimized to produce useful devices.

Sc Improves Optical Damage Resistance of $LiNbO_3$

$LiNbO_3$ is an important optical material, which is used in optical switches, waveguides and parametric oscillators, because of unusual linear and nonlinear optical properties [also see **RIC Insight, 5**, [4], 2 (April 1, 1992)]. The major problem is that $LiNbO_3$ is easily damaged upon exposure to laser radiation. MgO has been successfully added to $LiNbO_3$ to increase its resistance to optical damage, but the large MgO concentration (5 mol%) makes it difficult to grow high quality single crystals. Japanese scientists from the National Institute for Research in Inorganic Materials, Tsukuba, Ibaraki, and Hitachi Metals, Ltd., Kumagaya, Saitama (J. K. Yamamoto et al., **Appl. Phys. Lett., 61**, 2156 (1992)] were able to dope the $LiNbO_3$ with 1 mol% Sc_2O_3 and improve its resistance to optical damage by a factor of two over the undoped optical grade $LiNbO_3$. Apparently, this is the first time anyone has been able to add a trivalent dopant to increase the damage resistance level in $LiNbO_3$. Because of the lower impurity concentration (1 mol% Sc_2O_3) compared to the 5 mol% MgO additions, the authors believe that the growth of high quality Sc_2O_3 doped into $LiNbO_3$ single crystals using the Czochralski method is possible, although this was not a high priority goal of this initial study.

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