Rare-earth Information Center Insight

Center for Rare Earths and Magnetics
Ames Laboratory
Institute for Physical Research and Technology
Iowa State University, Ames, Iowa 50011-3020 U.S.A.

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LaB_6-based Decorative Hard Coatings

For a researcher in materials science, the mention of LaB_6 usually brings images of electron microscope filaments. However, there appears to be another potential use of the material as a decorative hard coating. V.-H. Derflinger *et. al. {Thin Solid Films,* **286**, 188-95 (1996)} discussed the alloying of LaB_6 films with Zr in an attempt to overcome the poor adhesion to metallic substrates due to high internal stresses and high brittleness of pure LaB_6 films. Using a cosputtering technique, the researchers produced a wide variety of film compositions. LaB_6 is attractive as a color coating due to its dark-violet color and high hardness. It was found that for Zr concentrations of less than 10%, these properties could be maintained. Films in this composition range were found to have improved substrate adhesion, which is attributed to stress relaxation due to the inclusion of Zr on La sites and the formation of amorphous phases.

Magneto-optic Readout Scheme

There is an old saying about "you can never be too rich..." These days you can probably add, "you can never have too many Gigabytes of storage" and so the quest to pack more and more information into less space continues. For magneto-optic recording, there are various factors which limit the bit density that can be obtained. One is the diffraction limit to the laser spot size, which as we have noted in the past few months, can be addressed by using shorter wavelength lasers. Another is the signal you can get from a submicron domain. This second problem has been addressed by Hiroyuki Awano *et.al. {Appl. Phys. Lett.,* **69**, [27], 4257-59, (1996)}. The recording media consists of a multilayer structure on a poly-carbonate disk. The active layers, and the ones of interest to us, are a 200nm TbFeCo recording layer and a GdFeCo readout layer. The TbFeCo layer is a high-coercivity layer where the data bits are recorded using laser pumped magnetic field modulation (LP-MFM). The GdFeCo is magnetically soft and the domain structure copies that of the nearby hard layer in zero field. The data is recorded such that a bit domain is perpendicular to the layered structure. If a magnetic field is applied parallel to the magnetization of the bit, the corresponding domain in the GdFeCo layer expands. Since the domain size is smaller than the laser spot size, this results in a significant increase in signal. If the field is antiparallel, the readout domain is decreased so the readout signal can actually be modulated.

Three Rare Earths, Three Colors, Three Dimensions

Imagine a true three-dimensional (3D) display that can be viewed from any direction, can display a real time image and can do all of this in three colors. A prototype of such a display has been demonstrated by E. Downing *et. al. {Science,* **273**, 1185-89 (1996)}. The display uses an adaptation of the idea of defining a point as the intercept of two lines of excitation, which must be combined in

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order to produce the desired response. In this case two-step, two-frequency (TSTF) upconversion is used. In this process, an ion is excited to a low lying excited state by the absorption of a photon at one wavelength, and before it can decay to the ground state, it is further excited by a photon of a second wavelength. The ion then relaxes radiatively by emitting a photon at a shorter wavelength than either of the exciting photons. Using rare earth-doped glass and two near-infared (IR) laser beams from laser diodes, Downing and coworkers were able to trace 3D Lissajous figures. Using Pr^{3+} (red), Er^{3+} (green), and Tm^{3+} (blue), they were able to produce a three-color image. Before you can buy one of these displays for your PC, there are a number of problems which must be overcome. First, all three RE ions can not simply be doped into the glass. The reason for this is that if the concentration of RE ions is too high, they interact which leads to nonradiative decay paths. Also, some of the wavelengths required for TSTF, for one RE, produce single-frequency upconversion with one of the other RE ions which would result in a line through the display. These difficulties can be overcome by producing a display made of a stack of three layer sets, each doped by one RE. The authors also pointed out that laser arrays will be necessary in order to keep the power dissipation below that required to melt the glass.

Flat CRT's

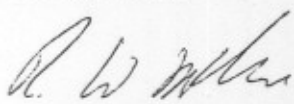
A recent report in *Science,* **273**, 1173-74 (1996) does not mention rare earths once, but, never the less, may describe events that have significant impact on one area of the rare-earth market. The report covers the First International Vacuum Electron Sources Conference. At the conference, significant advances in field emission sources were described. The sources are used in field-emitter displays which may some day provide large area flat panel displays. Since the light from these displays is produced in the same fashion as in CRT's, the development of such displays would keep rare-earth phosphors at the forefront of display technology.

$Nd_2Fe_{14}B$ Gears

The torque transfer in a gear system made from multipole cylinders of bonded Nd-Fe-B magnets has been measured by D.M. Tsamakis *et. al.* {*J.Alloy Compds.*, **241**, 175-79 (1996)}. As would be expected, the number of poles is a direct analog of the number of gear teeth. Of course, when you exceed the maximum allowable torque for the magnetic system, the resulting slip does not strip the teeth off. One interesting result is that there is a critical distance between shafts. For short distances the torque transmitted increase with the number of poles, while for long distances the torque decreases with the number of poles. Presumably, this distance scales with the shaft diameter in some fashion.

RIC News

As you probably know, we are going through the process of the first-ever complete update of the RIC mailing list. As our sponsors, most of you have been contacted to insure that no one currently in your organization is dropped. If we have not contacted you (which probably means we do not have your FAX number) and there are people in your organization other than yourself who wish to receive the *RIC News*, please contact us and we will send you the list we have for updating.



R. W. McCallum
Director CREM/RIC