Rare-earth Information Center INSIGHT

Ames Laboratory
Institute for Physical Research and Technology
Iowa State University / Ames, Iowa 50011-3020 / U.S.A.

Volume 7 | June 1, 1994 | No. 6

Mt. Weld on Hold

After the completion of the assessment of the Mt. Weld Rare Earth Project, Ashton Mining decided to put the project on "hold". At the present time their evaluation of the near-term rare earth markets and the worldwide economic slow down led to the conclusion that the financial returns do not warrant the risks associated with the large capital investment to develop this resource to be a major supplier in 1996. However, Ashton Mining still remains committed to the long term development of Mt. Weld as a strategic source of cerium products. They feel that the project will be developed later in the decade and thus they placed the project on "hold" rather than in "mothballs".

Mt. Weld is one of the richest rare earth deposits in the world in terms of its rare earth concentration (10.2%). Furthermore, the deposit is low in radioactive thorium. The rare earth content of the deposit is sufficient to supply fifteen to twenty percent of the present world's demand for over twenty years. For more information about this deposit see **RIC Insight 4** [1] (January 1, 1991). The projected plans had a goal of producing 4000 tons of CeO_2 per year at full production.

Super GMR Effect

Scientists at AT&T Bell Laboratories [S. Jin *et al.*, **Science 264**, 413 (15 April 1994)] announced the observation of an extraordinarily large (-127,000% at 77K and -1300% at 260K) giant magnetoresistance (GMR) effect in a La-Ca-Mn-O film. The 77K GMR result is nearly a 1000-fold increase over the largest GMR effect observed heretofore (~-150%) — a tremendous change in the state-of-the-art.

The GMR effect was discovered about eight years ago and is caused by spin-dependent scattering in metallic multilayers, or in heterogeneous alloy films, or spinodally decomposed alloys. It is not only characterized by a large magnetoresistance (typically -5 to -50%) but by its negative value and by its independence of the field orientation. The magnetoresistance ratio is defined as the difference in the resistance at 6T (60kOe) and at zero field divided by the 6T resistance ($\Delta R/R_H$).

The La-Ca-Mn-O films (1000 to 2000Å thick) were epitaxilly grown on the (100) orientation of a single crystal $LaAlO_3$ substrate using a pulsed laser deposition technique. The target had a nominal composition of $La_{0.67}Ca_{0.33}MnO_x$. The substrate was maintained at a temperature of 600 to 700°C during the deposition, which was carried out under a 100 mtorr partial O_2 atmosphere. The authors found that $\Delta R/R_H$ varied with temperature reaching a peak $\Delta R/R_H$ value

- more -

Telephone: (515) 294-2272
Facsimile: (515) 294-3709
Telex: 283359
BITNET: RIC@ALISUVAX

and then fell-off in a more-or-less symmetrical manner with either increasing or decreasing temperature. The $\Delta R/R_H$ value at the peak and the peak temperature varied with heat treatment temperatures and times. These changes could be due to oxygen stoichiometry, epitaxy, defect density, chemical inhomogeneity and substrate-film reactions. The authors note that the exact mechanism for the GMR effect in La-Ca-Mn-O films is not known but it seems to be related to the semiconductor — metal transition.

Although other scientists have observed the GMR effect in other manganese magnetic oxide films, the largest values reported prior to now were only -150% at best. The large values reported by the Bell Laboratory group, are ascribed by the authors to be due, at least in part, to the superior quality of their films and the high degree of lattice matching between the film and substrate.

If these oxide materials can be reproducibly processed to give the optimum GMR properties at room temperature these materials could revolutionize magnetic recording, memory and sensor technologies. In the long term this could be an important rare earth market within a decade.

How Does the Phosphor Market Grow?

An excellent review of the phosphor market appeared in the April 1994 issue of **Chemical Business 16**, [4], 17. The article, written by T. Wett, reviews the phosphor markets of the early 1990's and projects what they may look like at the turn of the century. The main emphasis is on the rare earth phosphors and the competition they face, although he also discusses non-rare earth phosphors. The color television or cathode ray tube (CRT) technology utilizing rare earth phosphors face a fierce fight from the liquid crystal display (LCD) technology for the flat panel display (FPD) screens 14 inches (35.5 cm) or larger. At the beginning of the 1990's, the number of CRTs produced was 110 million vs. about 2 million LCDs. By the year 2000 the CRT's are projected to grow slowly to about 130 million, but the number of LCDs will jump to about 50 million. However, this prediction is much more favorable for the rare earth industry than it was four years ago [see **RIC Insight 3** [6] (June 1, 1990)] when it was estimated by a LCD proponent that the number of CRTs and LCDs manufactured would be the same in 1997.

The other major rare earth market is trichromic fluorescent lamps, and it has been growing at more than 10% per year. In 1989 about 200 million tubes had been produced. This market is expected to grow at least at this rate or even faster, and will surpass the CRT market for the amount of rare earth phosphors utilized by the end of this decade. The drive for energy savings will help expand this market. The trichromic phosphor tubes consume about 20% of the electricity used in an incandescent lamp for the same lumen output and last six times longer. It has been estimated that in 1990 alone, 6.25 gigawatts (10^9 watts) of energy was saved by using fluorescent lamps containing rare earth phosphors instead of conventional lamps — the equivalent to the power output of about six large electrical generating plants.

Karl A. Gschneidner, Jr.

K. A. Gschneidner, Jr.
Director, RIC