Rare-earth Information Center INSIGHT

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Volume 9 | RIC Insight | July 1, 1996

Giant Magnetoresistance:

Giant magnetoresistance (GMR) is a remarkable phenomena where the resistance of some materials drops to 1/4 or less of the zero field value when a magnetic field of several Tesla is applied. This effect is dramatic in $La_{0.7}Ca_{0.3}MnO_3$. Two recent papers deal with different aspects of this material which is not yet truly understood. J. Fontcuberta *et al.*, **Appl. Phys. Lett., 68,** 2288-2290 (1996) report on the thermopower in $(La_{1-x}Y_x)_{0.67}\,Ca_{0.33}MnO_3$. Thermal power is of interest because it is indicative of the carrier concentration in a material. The measurements show that an extraordinarily large thermopower is developed close to the ferromagnetic ordering temperature which is below room temperature. The material also shows a pronounced peak in the resistivity. The purpose of the Y substitution is to change the mean lanthanide radii. This, in turn, results in an bending of the Mn-O-Mn bond. The authors argue that increasing Y concentration causes a narrowing in the band width of a two band structure, which in turn effects the thermal excitation between the two bands and produces the observed concentration effects on the temperature dependence of both the resistivity and the thermopower. R. Mahesh *et al.*, **Appl. Phys. Lett., 68,** 2291-2293 (1996) have studied the effect of particle size on the giant magnetoresistance in the non-Y doped material. The samples were prepared by a sol-gel process. By varying the process temperature, the grain size in the resulting sintered powder compact could be systematically varied. Interestingly, the Curie temperature is a function of grain size but the maximum magnetoresistance near T_c is not dependent on this parameter. At low temperature (4.2 K), the magnetoresistance increases with decreasing particle size, a phenomena the authors attribute to contributions to the GMR from the grain boundaries.

Optical Properties of Er

The optical properties of the rare earths, and of Er in particular, continue to be of interest. The Er^{3+} emission at 1.54 μm is of particular interest since that wavelength lies in the minimum loss region of the optical fibers used for fiber optical communications. As was discussed in May with respect to Nd in electro-optic polymeric devices, if suitable concentrations of rare earth can be doped into a suitable host, amplifiers based on the laser principal can be made to compensate for losses in the communications system. U. Hömmerich *et al.*, **Appl. Phys. Lett., 68**,1951-1953 (1996) have studied the luminescence of Er in porous silicon. In these experiments, Er was ion

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implanted into silicon wafers which had been anodically etched in order to create controlled porosity. The porosity in the Si effects the photoluminescence of the Si itself. Hömmerich demonstrates that the Er^{3+} luminescence and the Si nanostructure, which determines the band gap, are related. This provides a means of tuning the properties of the composite material. In a second paper, G. N. van den Hoven *et al.*, **Appl. Phys. Lett., 68**, 1886-1888 (1996) have created a 4 cm long Er-doped Al_2O_3 spiral wave guide amplifier on a Si substrate. As in the previous paper, the Er doping was achieved by ion implantation. The experimental results are in good agreement with model calculations and the authors predict a net optical gain of 20 dB for an optimized amplifier.

Wavelength-Multiplexed Holographic Recording

In wave-length-multiplexed recording, several pieces of data are stored in one physical location. This is accomplished by storing different pieces of data in different parts of the spectral response of the material. To visualize this process, consider having a film where you can independently determine the optical absorption of red, blue and green light at any physical location on the film. You can then record one "black and white" image which can be seen under a red light, a second for blue and a third for green. For data, this process is performed by recording and reading out the image using a tunable laser. Until recently dye lasers, which are generally large and not suitable for incorporating in your average PC, have been the only wavelength tunable coherent light source. With the advent of the commercial availability of small high powered wavelength tunable laser diodes, this limitation is removed. In addition, single crystal strontium barium niobate (SBN) single crystals have been found to work as a phorefractive recording media, which has high recording sensitivity, high diffraction efficiency, high temperature stability and is rewritable and does not require a developing process. Based on these two developments, T. Kume *et al.*, **Jpn. J. Appl. Phys., 35,** 448-453 (1996) have demonstrated wavelength-multiplexed holographic recording using Ce doped SBN single crystals. The authors have analyzed their experimental results and have derived theoretical wavelength and angle selectivity's for the holographic gratings. Based on these results, they predict that 300 to 400 holograms can be multiplexed.

Corporate News:

SPS Technologies, the parent company of Arnold Engineering, has acquired Flexmag Industries, Inc., a subsidiary of Dynacast, as well as Dynacast's injection molded magnets business. The acquired businesses have been combined with Arnold. The acquisition adds flexible bonded magnets and injection molded magnets to Arnold's range of magnetic materials.

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