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.

Volume 10 | November 1, 1997 | No. 11

### *Submicron Sized $Y_2O_3$ Based Phosphors*

For high resolution low-voltage emissive displays, submicron particles of phosphor are desirable. In particular, spherically shaped particles, without defects, which allow the non-radiative decay of the excited ions, are desirable. An interesting way of producing such particles has recently been advanced. Chongying Xu et al. {*Appl. Phys. Lett.*, **71**, 1643-5 (1997)} described an aerosol synthesis method, which seems to be a sophisticated version of shaking up a pop bottle and creating a fine spray of liquid, which is then directed through a furnace. In this case, an aqueous solution of $Y(NO_3)_{3.5}H_2O$ and $Eu(NO_3)_{3.5}H_2O$ is saturated with supercritical $CO_2$, forming a microemulsion. When the resulting solution is decompressed through a restriction, the $CO_2$ expands and creates a very fine aerosol. The metal nitrate aerosol droplets are introduced into a furnace at 1010°C. The pyrolized powders consisted of spherical powders with particle size ranging from 0.1 to 1 μm in diameter. The as-prepared powder was poorly crystallized and required a 1h anneal at 1200°C to exhibit the sharp x-ray diffraction peaks characteristic of $Y_2O_3$. The materials exhibited bright-red luminescence when excited with 254 nm UV light. When excited with electrons, the intensity of the luminescence was twice that of the industrial red Y-Eu oxide phosphor (P56). The large increase in luminescence is attributed to the increase in specific surface area of the fine particles.

### *Hydrogen Passivation of Defects*

The photoluminescence of rare earth ions have been studied and used in a wide variety of hosts. U. Hommerich et al. {*Appl. Phys. Lett.*, **71**, 1807-9, (1997)} have recently reported on the use of the wide band gap semiconductor, AlN doped with Er. Excitons in a wide band gap semiconductor have a relatively large binding energy, which increases their thermal stability. This allows efficient energy transfer to the RE ion. Unfortunately, many of these materials grow with very high dislocation densities, which results in considerable non-radiative decay of the RE excited state. Hommerich et al. demonstrated that the competitive recombination centers associated with these defects can be passivated by hydrogen. Actually, for reasons not explained in the paper, they used deuterium, and one can only assume that the higher mass plays a role in the passivation. The hydrogen treatment is effective over only a narrow range of temperatures, since the pressures used the H isothermally desorbed at 300°C, while the diffusion rate below 200°C is not sufficient to fully hydrogenate the material. The room temperature photoluminescence of the $Er^{3+}$ is enhanced by a factor of five by the treatment, and the effect is totally reversible with the removal of the H.

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***Hydrogen Storage***

K. Kadir et al. {*J. Alloy Compds.*, 257, 115-21 (1997)} have reported what they claim is a new series of hydrogen storage alloys $RMg_2Ni_9$ with R = La, Ce, Pr, Nd, Sm, and Gd. In their initial paper, the authors reported only the synthesis and processing of the materials and do not give the storage capacity of the material. The structure is said to be based on alternating $MgNi_2$ Laves phase and $AB_5$ layers. The materials were prepared by solid state synthesis, starting either with $MgNi_2$ and $RENi_5$ or directly the elemental constituents. The elemental route was found to be the most favorable for producing the most nearly single phase material.

***Pore Initiation for Highly Porous Electrodes***

Iridium oxide-based electrodes have been developed for use as oxygen generating electrodes in industrial electrolytic plating. These electrodes have large capacitances, which suggests their application in an electrochemical capacitor system. For this application, even higher capacitances is desired. Since the capacitance of the electrode depends on the surface area, a highly porous electrode should have higher capacitance. In order to produce a high porosity electrode, Y. Murakami et al. {*J. Alloy Compds.*, 259, 196-9 (1997)} have prepared electrodes by the thermal decomposition of $IrC_l$ and $RC_l$. The electrodes $IrO_2$-$R_2O_3$/Ti (R: rare earth ion, Ir:R = 7:3) were treated in $H_2SO_4$. After treatment, the rare earth ions were found to be completely removed from the electrode. The resulting highly porous electrodes exhibited an enhanced voltammetric charge.

***Gold-dispersed (Pb,La)$TiO_3$ Films***

Non-linear optical devices require high stability, when subject to intense laser irradiation, and must exhibit high speed response. Metal-dispersed ferroelectrics, which have high refractive indices have been investigated for this application, and recently, T. Sei et al. {Mater. Sci. Eng., **B49**, 61-5, (1997) have prepared a series of gold-dispersed $Pb1\text{-}1.5_xLa_xTiO_3$ (PLT) thin films, where the refractive index has been varied. The films were prepared by a sol-gel process. The volume fraction of Au was varied from 0 to 10%, while x was varied from 0 to 0.3. The refractive index of the matrix was found to increase with increasing crystal size. The optical properties of the film could be explained by considering the static electric field of the matrix, which influenced the surface charge of the gold particles.

***Mechanically Alloyed $Nd_2Fe_{14}B/\alpha Fe$ Nanocomposite Additions***

Remanence enhanced exchange coupled magnets based on $Nd_2Fe_{14}B$ and $\alpha Fe$ have been studied extensively for the last seven or eight years. The majority of these studies have been performed on rapidly solidified material, where the required nanocomposite microstructure may be obtained under appropriately controlled conditions. Exchange enhanced magnets have also been produced by mechanically alloying by a number of groups. One recent study by P. Crespo et al. {*J. Phys.D: Appl. Phys.*, **30**, 2298-303 (1997)} investigated the effect of alloy additions of Si, Cu, Zr, and $Nd_3Cu$. The elemental additions were chosen because they have been observed to limit grain growth in some Fe based soft magnetic systems. Samples were prepared by ball milling the constituent elements followed by isothermal anneals. Zr and Si additions were found to widen the window for annealing the materials allowing higher processing temperature.

R. W. McCallum
Director CREM/RIC