Rare-earth Information Center INSIGHT

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Center for Rare Earths and Magnetics

As you may recall from Karl Gschneidner, Jr.'s farewell in the February 1, 1996 issue of **RIC Insight**, the RIC is now part of the Center for Rare Earths and Magnetics (CREM). CREM has been formed within the Institute for Physical Research and Technology. The center is structured as three units: information, technology, and research. The Rare-earth Information Center will continue to operate as it has in the past with sponsorship of the RIC independent of participation in other CREM units. The Rare Earth Technology Unit will pursue the development of material production technologies based on industrial requirements. The Magnetic Materials Research Unit will focus on basic and applied research on a broad range of topics in magnetism and magnetic measurements. One goal of CREM is to provide solutions to industrial problems in a timely and cost effective manner. In order to meet this goal, industrial partners for CREM are currently being sought. Industrial partners will establish a contractual relationship with CREM so that when the need arises for a rapid solution to a problem, questions of intellectual property, overhead cost structure etc. will already be agreed upon. The industrial partners also serve as an advisory board to determine the center's direction. We would like to invite you to a meeting to be held at the Chicago airport for the purpose of establishing the advisory board from 9:30 AM to 4:00 PM on June 21, 1996. If you are interested in attending please contact me at the RIC, fax number (515) 294-3709.

LSCO/PNZT/LSCO Ferroelectric Capacitors

Ferroelectric thin film capacitors are currently the subject of a considerable amount of interest due to their potential to be used in nonvolatile memory elements with existing silicon based technology. Two recent papers, A. M. Dhote *et al.*, **Appl. Phys. Lett., 68,** [10], 1350-1352 (1996) and H. N. Al-Shareef *et al.*, **Appl. Phys. Lett., 68,** [2], 272-274 (1996) deal with the development of these capacitors. The ferroelectric is $Pb(Zr,Ti)O_3$ perovskite with Nb doping (PNZT). Compatible electrodes are made of $La_{0.5}Sr_{0.5}CoO_3$, (LSCO) also a perovskite. Al-Shareef *et al.* focus on the low temperature processing of the capacitors which is necessary to remain compatible with silicon technology while Dhote *et al.* investigated buffer layers which will make possible vertical integration of the capacitor-transistor memory configuration. The LSCO/PNZT/ LSCO ferroelectric capacitor stack was fabricated by two different approaches. Al-Shareef *et al.* used RF magnetron sputtering to deposit the LSCO layers and a multilayer spin-on sol-gel process for the PNZT layer while Dota *et al.* used pulsed laser deposition for all layers of the stack. In both processes it is necessary to crystallize the as-deposited material. Al-Shareef *et al.* demonstrated that capacitors processed between 550°C and 675°C exhibited very good fatigue properties and capacitor properties. Dhote *et al.* produced capacitors with platinized conducting barrier layers of TiN/poly-Si on a Si substrate. The role of the conducting layer in a finished device would be to provide direct electrical contact from the drain of the transistor to the bottom electrode of the ferroelectric capacitor so that the

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complex three-dimensional structures needed for integration of high density nonvolatile memories may be achieved. LSCO has been selected for the electrodes in these capacitors since the conductivity of the rare earth - transition metal - oxide can be controlled by varying the La/Sr ratio and the perovskite structure provides a good match to the perovskite PNZT layer.

Epitaxial Y-doped $SrZrO_3$ Films

Materials which exhibit high temperature protonic conduction are of considerable interest for fuel cells, electrolyzers, and gas sensors which require a high degree of hydrogen solubility. One material of current interest is Y-doped $SrZrO_3$. In order to separate lattice conduction from grain boundary conduction, single crystal materials are required. While single crystals have been prepared by the float zone process, this approach is quite difficult. L. Beckers *et al.*, **J. Appl. Phys. ,79,** [6], 3337-3339 (1996) have prepared high quality epitaxial films of Y-doped $SrZrO_3$ on MgO single crystal substrates. The lattice match to the MgO (001) crystal is 2-3% which permits what is claimed to be perfect epitaxy. Pulsed laser deposition (PLD) was used in preparing the films. A KrF excimer laser was used with a single phase Y:$SrZrO_3$ target. Rutherford backscattering spectrometry/channeling was used for sample characterization and conventional x-ray diffraction was used to analyze the epitaxial orientation of the films.

This paper and the papers mentioned in the previous section emphasize the increasing use of pulsed laser deposition in preparing high quality films of rare earth - transition metal - oxide materials. The first use of PLD for this type of material was to prepare high quality, high-temperature superconducting oxides. The advantages of PLD include high growth rates and the ability to reproduce the composition of the target in the film even for compound targets. Deposition in reactive atmospheres is also possible. From the increasing variety of research areas using this technique, it clearly warrants attention from the rare earth community.

Notes from Japan

The Japanese trade paper, "Nikkei Sango Shinbun", reports in its May 28, 1996 issue that yttrium prices are continuing to increase in Japan. The rise is said to be fueled by its use in Y_2O_3 red phosphors for fluorescent lighting and cathode ray tubes. The demand for CRT's is driven by Southeast Asia's demand for color TV's and the rapidly growing computer monitor market. "Kagaku Kogyo Nippo" (May 27, 1996) reports that Sumitomo Metal Mining Co. will double production of rare earth-based magnet materials. The double-digit yearly growth for these materials is due to the increased demand for PC's where they are used in disk drives and CD-ROM's (translated articles provided by K. Shimomura, Nissho Iwai Corp.).

Seminars

TERFENOL-D Technology Seminar, September 16-17, Ames, IA, Contact Linda Hurley, ETREMA Products, Inc. (800) 327-7291.

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