Rare-earth Information Center Insight

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The RIC in Transition

The past year has been one of considerable change for the RIC with the change in directorship as founder, Karl Gschneidner Jr., approached his goal of returning to full time research. With additional support from Iowa State University through IPRT, the RIC moved to new facilities next to my office in Wilhelm Hall. The move allowed us to consolidate office and archive facilities in an improved work environment. We have also been engaged in updating both our procedures and our appearance as you have seen in the new *Insight* letterhead and the masthead from the *RIC News*. We are just about to realize our goal of placing the last four issues of the *RIC News* on the World Wide Web. During the next year we will be contacting our sponsors about providing links to their sites and references for product lines and contact personnel. We look forward to providing both expanded and better service to our sponsors in 1997.

Tunable Er:Yb Bulk Laser

With the ever increasing demand for transmission of both voice and data, there is a large driving force for the improvement of lasers and amplifiers used in optical communications. Thus each month we see new developments in lasers based on rare earth materials. Recently,S. Tacchero *et. al.* {*Appl. Phys. Lett* **69**, [21], 3128-30 (1996)} have reported a single frequency, linearly polarized Er:Yb glass laser which is tunable over the third optical communications window from 1528 to 1564 nm. The fundamental emission for the laser is the Er emission peak at 1535 nm. While not stated in the paper, it is assumed the Yb is used as a sensitizer to improve pumping efficiency. This was discussed in conjunction with upconversion and lasing in the November 1, 1996 *Insight*. The improvements announced by Tacchero *et al.* stem from design improvements which overcome the limitations of previous lasers. These problems include non-single frequency operation in ring fiber lasers and a very narrow range of operation for short Fabry-Perot fiber lasers and traveling-wave fiber lasers. The bulk laser uses a 1 mm thick disk of active material and hence is a bulk laser. The resonant laser cavity is tuned using a piezoelectric transducer which moves the output mirror. A polarizing filter in the cavity is used to suppress unwanted oscillation modes resulting in a single frequency laser.

X-ray Sources

We do not normally think of rare earths in conjunction with x-ray sources but developments resulting from efforts to develop x-ray lasers in conjunction with the "Star Wars" program may change that. For x-ray lasers, a plasma of heavy metal ions is created and excited to produce the required population inversion for lasing action. The heavy ions are required in order to have bound states of sufficiently high energy, while the temperature required to thermally populate these states is well above the vaporization temperature of the metal. One class of x-ray lasers uses Nd:YAG lasers to create and excite the plasma in a single step. Using a laser facility based on Nd:YAG oscillators followed by glass amplifiers,

M. Fraenkel *et. al.* {*J. Appl. Phys.*, **80**, [10] 5598-602 (1996)] have studied the production of x-rays in the 4-14 Å range. The laser energies used were in the 1-15 J range which produced estimated maximum intensities of about 10^{14} W/cm^2. Targets included stainless steel, samarium, molybdenum, gold platinum, Saran, NaF, sulfur, and barium fluoride. For the spectral range from 8-12 Å, samarium proved to be the optimal target material.

New Nd Laser Material

In response to an increasing variety of applications for non-linear optical materials, a variety of inorganic non-linear materials have been developed. Following the same trend as in high temperature superconductors, abbreviated names such as BBO for BaB_2O_4, LBO, not leveraged buy out, but LiB_3O_5 and KTP ($KTiOPO_4$) describe these new materials. The above mentioned materials have contributed significantly to non-linear optics (NLO) but they all melt incongruently. This means that crystals of these materials must all be grown by the flux growth method which limits the size and may effect the crystal purity due to the inclusion of flux pockets within the crystal. G. Aka *et. al.* {*Eur. J. Solid State Inorg. Chem.*, **33**, 727-36 (1996)} have prepared crystals of a new compound $Ca_4GdO(BO_3)_3$, called GdCOB, which is congruently melting and can be doped by Nd to provide laser emissions at 1.06 μm. Frequency doubling was also observed which, under suitable conditions in an oriented crystal, allowed the generation of the second harmonic of the fundamental IR laser beam resulting in a visible green laser. The crystals were grown from the melt by the Czochralski method. The crystals are monoclinic and melt congruently at about 1480°C. The refractive indices along the three crystallographic directions are not equal. This results in optical axes which are not equivalent to the crystallographic ones. The material is stated to be one of a very few self frequency doubling materials.

GdBaCuO Bolometer

Despite the typo in the title labeling it a semiconductor, the $GdBa_2Cu_3O_7$ bolometer described by V. Yu. Zerov *et. al.* {*Tech. Phys. Lett.*, **22**, [6], 496-8 (1996)} is based on a superconducting film. The bolometer uses the rapidly changing magnetic susceptibility of the thin film as a function of temperature in the region of the superconducting transition as a highly accurate thermometer. Instead of measuring the susceptibility directly as has been done in previous bolometer designs, the film is used to screen the magnetic flux from the pickup coil. This enhances sensitivity since the geometrical factors are much more favorable than in the conventional AC measurement. The susceptibility measurement is favored over resistance measurements since no contacts are made to the film and 1/f noise associated with current passing through the sensing element is greatly reduced. The paper shows that there is significant potential for developing HTSC bolometers based on magnetic susceptibility.

CREM NSF Proposal

In response to and NSF call for proposals for Engineering Research Centers (ERCs), the Center for Rare Earths and Magnetics, of which the RIC is a part, has submitted a letter of intent to submit a proposal dealing with the processing of rare earth materials. The tentative title for the proposal is "Processing and Microstructural Control During Solidification of Commercially Important Alloys". This topic was chosen as a crucial element in the science base required to produce all types of advanced materials and, of course, rare earth systems will be prominently featured in the proposal. The proposal process is a two-step process with a preproposal due March 7, 1997. An important element of a successful preproposal and subsequent full proposal is a well established plan for industrial collaborations. For further information please contact me.

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