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

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Amorphous Films by Solid State Reaction

An amorphous film of $Y_{51}Mo_{49}$ has been produced by Y. G. Chen and B.X. Liu, **Appl. Phys. Lett., 69,** [220], 3096-3098 (1996), by a rather unusual process. A multilayer structure of Y and Mo, which are immiscible, were deposited in ultrahigh vacuum and then annealed at 300°C. The as-deposited layers of the multilayer were crystalline, while the annealed film was amorphous. The amorphous films recrystallized at about 600°C. While this may seem to imply that the glassy state is the ground state for the Y - Mo system, this is not the case. In the as prepared multilayer, 19% of the atoms were interfacial. The interfacial layers contributed both chemical and elastic energy to the free energy of the system raising the free energy of the crystalline layers above that of the amorphous state. The low temperature anneal allowed the structure to relax to the metastable amorphous state. Using this technique, amorphous films 300nm in thickness were prepared and the elastic properties of the film were characterized by nanoindentation. The elastic modulus and nanohardness of the amorphous films increase with increasing annealing temperature until they are equal to the crystalline values. This is attributed to a reduction of free volume with increasing annealing temperature and a corresponding increase in short range order.

90 Degree Kerr Rotation

A magneto-optical Polar Kerr Rotation of 90 degrees has been reported by R. Pittinni *et al.*, **Phys. Rev. Lett., 77,** [5] 944-947 (1996). The rotation was measured in CeSb which had previously shown a maximum of 14 degrees. The enhanced value results not from an improvement in the material but rather from an extension of the measurement range. Previous measurements of CeSb had demonstrated that the Kerr Rotation was a strong function of photon energy with the rotation actually passing through zero. These measurements had a lower limit of 0.55eV at which point the Kerr angle was still increasing with decreasing photon energy. The current measurement extends the low-energy limit to .23eV. The 90 degree rotation, the maximum observable value, occurs at 0.46 eV. Despite the high value, do not expect to see this material in your magneto-optic storage disks, the maximum was measured at 1.5K and a magnetic field of 5T. The existence of the maximum should be of considerable interest theoretically since Ce compounds frequently lie on the borderline between well-localized and itinerant f electrons. The maximum value predicted for these compounds by present band theoretical treatments is of order of a few degrees.

Nd^{3+} Doped Dosimeter

We are all familiar with the use of the optical transitions of Nd^{3+} in such applications as Nd:YAG lasers, but the use of one of these transitions for heating is fairly novel. A. L. Huston *et al.,* **Appl. Phys. Lett. 68,** [24], 3377-3379 (1996), report just such an application in their description of a fiber optic coupled, laser heated thermoluminescence dosimeter. A thermoluminescence dosimeter is a means of

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Telephone: (515) 294-2272
Facsimile: (515) 294-3709
[redacted]
Internet: RIC@AMESLAB.GOV

measuring radiation dosage. The active material, in this case Cu doped ZnS nanocrystals embedded in a Vycor glass, has a metastable excited state which become populated when the material is exposed to radiation, in this case ultraviolet or ^{60}Co γ radiation. When the material is heated, the metastable states depopulate emitting a photon. Since the population of the metastable states is determined by the total radiation dose received prior to heating the amount of light given off on heating is directly proportional to the dose received. The standard use of such a dosimeter involves removing the dosimeter from the measurement location and heating it in a readout instrument. For measurement of radiation levels in hazardous areas or applications such as *in situ* ground water monitoring, it is desirable to read out the sensor remotely. One scheme for doing this involves attaching the dosimeter to the end of a fiber optic filament, which is used for both laser heating of the dosimeter and conducting the emitted light back to the photomultiplier. The major problem with this approach is obtaining uniform heating of the dosimeter. Huston *et al.* have doped the glass containing the ZnS with Nd^{3+} ions, which strongly absorb photons from a GaAlAs laser, but whose absorption bands do not significantly overlap the thermoluminescence emission band. Furthermore, a significant fraction of the excited Nd ions decay non radiatively, efficiently heating the material. The heating scheme is shown to be so efficient that the normal rounding of the luminescence peak due to thermal gradients in the sample are not observed. Readout time is about 15 seconds after which the dosimeter is ready to be used again.

Negative Differential Resistance

Years ago, when a report of negative resistance was published in a trade magazine, I joked that the Department of Energy was out of business. What M. Tanaka *et al.,* **Appl. Phys. Lett. 68,** [1], 84-86 (1996), reported is not a violation of thermodynamics, but rather a resonant tunneling structure having a buried ErAs semimetallic quantum well. This is an example of a epitaxial hybrid hetrostructure consisting of dissimilar materials. Such structures are expected to lead to new types of transitions. The AlAs/ErAs/AlAs resonant tunneling reported by Tanaka *et al.* exhibits an area in the room temperature current voltage (I-V) characteristic where dI/dV is negative. The total resistance remains positive. This Negative Differential Resistance (NDR) is the hallmark to tunneling through RE-V semimetallic quantum wells. This is claimed to be the first such observation at room temperature, and hence a large step toward making usable devices.

Thermoelectrics

A new class of thermoelectric materials is reported by B. C. Sales *et. al.,* **Science, 272,** 1325-1328 (1996). Thermoelectrics are used to convert heat to electricity in power sources for deep space probes but are currently to expensive and inefficient for such uses as converting waste heat from an automobile engine into electricity. They are also used to cool computer chips and the more mundane things you might put in thermoelectric ice boxes available at your local discount store. The new materials have the general formula RM_4X_{12}, where R is La, Ce, Pr, Nd, or Eu, M is Fe Ru, or Os and X is P, As, or Sb. While the materials have not yet been optimized, several alloy compositions in the range $RFe_{4-x}Co_xSb_{12}$ with R = Ce or La, have large values of ZT, the thermoelectric figure of merit. Z is a function of the thermopower, the electrical resistivity and the thermal conductivity, while T is temperature. At 800K, ZT approaches 1, which is comparable with the best values of any previously studied thermoelectric material. The authors predict that optimization of the materials should result in a value of ZT=1.4.

R. W. McCallum
Director CREM/RIC