Rare-earth Information Center

Insight

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*Naming the Heavies*

The honor of naming elements has traditionally gone to the discoverer. The problem is that it is not always clear who was the first to produce an element that is so unstable that it decays before a conventional chemical test can be made. As a result, there has been a long standing dispute as to the names of the transfermium elements 101 to 109. The periodic chart I purchased for my office when I came to Ames, eleven years ago, has Unnilquadium through Unnilhexium as the names for elements 104 to 106. Last month at the general assembly of the International Union of Pure and Applied Chemistry, names for these elements were finally adopted {http://chemistry.rsc.org/rsc/iupacnms.htm}. While I doubt that you will be finding these elements available from your favorite chemical supplier, they may be of interest:

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| 101 | Mendelevium | Md | after Mendelev who formulated the periodic table |
| 102 | Nobelium | No | in honor of Alfred Nobel |
| 103 | Lawrencium | Lr | in honor of US physicist Ernest O. Lawerence |
| 104 | Rutherfordium | Rf | in honor of Lord Ernest Rutherford |
| 105 | Dubnium | Db | in honor of the Dubna laboratory |
| 106 | Seaborgium | Sg | in honor of US physicist Glenn Seaborg |
| 107 | Bohrium | Bh | in honor of the Danish physicist Niels Bohr |
| 108 | Hassium | Hs | from Gesellschaft für Schwerionenforschung's (GSI) location in the German region of Hesse |
| 109 | Meitnerium | Mt | in honor of the Austrian physicist Lise Meitner |

For an interesting view of the search for super heavy elements, see the web site of the Gesellschaft für Schwerionenforschung {http://www.gsi.de/~demo/wunderland/englisch/Kapitel_02.html}.

*Cooling with Light*

Somehow, the idea of shinning a laser on a piece of material in order to cool it does not seem like a good idea but, in fact, it works. The idea was first suggested in 1950. Conceptually, you begin with an ion with two excited levels, the lower of which may be thermally populated. Assuming that the ion may be excited to the higher excited state by absorbing a photon, when in either the ground state or the lower excited state, it is possible to cool the material. In our conceptual model, we assume that the splitting between the ground state and the first excited state is small compared to kT so that the two levels are equally populated. If a photon with energy corresponding to the energy difference between the excited states is incident on the material, it can raise an ion in the first excited state to the second excited state. When the excited state decays by emitting a photon in our sample model, this excited state will decay with equal probability to the lower two states by emitting a photon. If the ion decays to the ground state,

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the emitted photon has more energy than the photon initially absorbed. Thus, there is a net cooling. Experimentally reduced heating has been observed as early as 1968, but only recently has net optical cooling been observed. C. E. Mungan et al. {*Appl. Phys. Lett.*, **71**, [11], 1458-9 (1997)} have recently extended studies of laser-cooling efficiencies of bulk ZBLANP ($ZrF_4$-$BaF_2$-$LaF_3$-$AlF_3$-$NaF$-$PbF_2$) glass doped with $Yb^{3+}$ to cover the temperature range from 100K to 300K. The complicated host was chosen because techniques have been developed to produce it with extremely high purity for telecommunications applications. Net cooling was observed for the region of the sample effected by the laser over the entire temperature range.

### *Blue Emitting Phosphor Films*

Given the amount of desk space occupied by most computer monitors, it is not surprising that there is an increasing interest in flat panel displays. One such technology is the full-color thin-film electroluminescent display panel. Naturally, there is considerable interest in producing large area films of appropriate phosphors for these displays, which includes studies of rare earth-activated alkaline earth thiogallates. These materials are easily fabricated as thin films by a number of techniques including RF-sputtering, multiple source deposition (MSD), molecular beam epitaxy (MBE), and low-temperature metallorganic chemical vapor deposition (MOCVD). Of these processes, RF-sputtering produces the best layers, but it suffers from one drawback. The as-sputtered films are amorphous and must be annealed at temperatures greater than 650°C. This requires an expensive high-temperature glass substrate, and may also create difficulties with the other thin film layers required for device fabrication. The other techniques tend to work well for small areas but not for manufacturing large screen displays. O. N. Djazovski et al. {J. Electrochem. Soc., **144**, [6], 2159-65 (1997)} have studied depositing Ce doped $SrGa_2S_4$ films by deposition from binary vapors. The distinction between their work and other direct evaporation techniques is that rather than trying to balance four elemental evaporation sources, a $Ga_2S_3$ source and a SrS source are used. The SrS source may be doped with Ce to obtain the desired composition. The authors determined that the evaporation from both sources proceeds by dissociation, and that in contrast to the SrS, the $Ga_2S_3$ evaporates incongruently complicating the process. However, with careful control, they were able to produce uniform crystal structures on substrates at 460°C.

### *Color Cathodoluminescent Screens*

Penetron screens were commercially manufactured from the late 1960's until the mid- 1980's. The screen consists of two layers of phosphor. A low energy electron beam is absorbed in the first layer emitting one color, while a higher energy beam penetrates into the second layer to excite a second color. The screens have higher resolution than conventional cathode ray tubes (CRTs) and were widely used in such applications as radar, where the lack of ability to display full color was more than compensated for by the higher resolution. V. D. Bondar et al. {J. Electrochem. Soc., **144**, [2], 704-7 (1997)} have developed an even higher resolution screen by replacing the traditional phosphor coating with a thin film, which removes the constraint of the phosphor particle size. A thin $Y_2O_3$-Eu film was deposited on a single crystal $Y_3Al_5O_{12}$-Tb,Ce substrate. A 4-5 kV accelerating voltage produced a red color due to complete absorption in the thin film, while 10 kV produced green. Peach and orange colors are produced by intermediate voltages. The resolution of the screen is determined by the beam spot size.

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