# Rare-earth Information Center INSIGHT

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## Ten *trillion*-fold Rate Enhancement

The use of lanthanum ions in catalyzing the hydrolysis of phosphonate esters was reported late last year by A. Tsubouchi and T. C. Bruice (University of California, Santa Barbara) in **J. Am. Chem. Soc. 116**, 11614-11615 (1994). The scientists were studying the catalysis of the hydrolysis of intracomplex phosphonate esters by two metal ions ($La^{3+}$) acting in concert, and they observed an extremely large and remarkable rate enhancement of $10^{13}$. This is probably the largest rate enhancement ever observed for such a hydrolysis. In modeling this hydrolysis process, the authors noted that the calculated distances from the $La^{3+}$ ligated water and the phosphonate oxygens are ideal for catalysis. This discovery may have an impact on studies of DNA, in which the cleavage of the phosphate diester bond is quite difficult to hydrolyze. It may also open other doors for the utilization of rare earth ions in catalytic processes for producing technologically and commercially important chemicals and products.

## Purification of Endohedral Metallofullerenes

Endohedral metallofullerenes are compounds in which metal atoms are trapped in the fullerene carbon cages, and are designated by the general formula $M@C_n$, where M is the metal atom and n indicates the number of carbon atoms which make up the fullerene cage. Metallofullerenes are produced by vaporizing a graphite anode containing a metal (or its oxide) in a carbon arc. The resulting product (soot) contains a mixture of empty fullerenes and metallofullerenes, which are difficult to separate, especially if one wants the metallofullerenes, since they are a minor product of the carbon arc process. Toluene has been used as a solvent to extract the metallofullerenes, and other processes have used high-pressure liquid chromatography (HPLC), but the processes at best are quite laborious. Recently, however, University of Michigan scientists have developed a fairly efficient process for producing metallofullerenes [J. Xiao, *et al.*, **J. Am. Chem. Soc. 116**, 9341-9342 (1994)]. They used a (CPTPP)-silica HPLC stationary phase to effect a one stage separation of $La@C_{82}$ and $Y@C_{82}$ from the empty fullerenes $C_{60}$, $C_{70}$, $C_{76}$, $C_{78}$, $C_{82}$, and $C_{84}$. [The acronym CPTPP stands for (*p*-carboxyphenyl) triphenyl-porphyrin.] In their process the emply fullerenes are extracted first and take about 25 minutes to be separated out at a flow rate of 1ml/min., and these are followed by the $La@C_{82}$ phase which requires another 10 minutes to extract it from HPLC apparatus. There is still a lot of exciting research in progress on these $M@C_n$ materials and some applications will develop as our knowledge base increases. We should not expect too many uses in the immediate future, since these materials are only about nine years old. However, this has not kept researchers from thinking about uses of fullerene materials. Two extensive reviews about applications and patents have appeared in the literature in the last year

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plus: the first by R. M. Baum, **Chem. & Eng. News 71** [47], 8-18 (November 23, 1993), and more recently by D. R. Huffman, **Mater. Lett. 21** 127-129 (1994). For earlier information see **RIC News 21** [1], 2 (March 1, 1986), and **RIC Insight 5** [4] (April 1, 1992) and **5** [10] (October 1, 1992).

**RIC's Prediction on Target**

About 2½ years ago (**RIC Insight 5** [6], June 1, 1992) we pointed out that field emission displays, FED's would be an important market for rare earth phosphors. Furthermore, FED's would be an important competitor to liquid crystals in flat screen displays (LCD's), which posed a big threat to CRT (cathode ray tube) displays, which is one of the most important rare earth markets. Recently, Raytheon Co., Lexington, Massachusetts announced it has established a manufacturing facility in Quincy, Massachusetts to make FED flat panel displays. Production is expected to start in a few months, close to three years after **Insight's** prediction "that the first FED models for laptop computers will be in production by 1995". As noted earlier, FED's will have brighter colors, use less power, and are not as bulky as a LCD flat panel display. Raytheon is licensing the FED technology from Pixel International of Rousset, France.

The Raytheon FED operates at high voltages (up to 10 kV) and demonstration models have reached a brightness of 10,000 fL at a luminous efficiency of 48 lumens per watt, which is significantly brighter than a backlighted LCD of the same size. The corresponding luminous efficiencies of a color LCD are 2 to 5 lumens per watt at a brightness of 25 fL. The cathodes are molybdenum microtips on soda-lime glass, with 384 tips per pixel. Rare earth phosphors are used to produce the lighted display. The FED's can also be monochromatic, in which case, only one rare earth phosphor would be used.

**Rare Earths Unit Unaffected by Reorganization**

Rhône-Poulenc's reorganization of their chemical operations was implemented at the beginning of this year. This involved merging the Specialty Chemicals unit with their Organic and Inorganic Intermediates group into a worldwide Chemical sector. The Chemical sector is divided into "Enterprises" which are structured around markets, product lines and technologies, and are organized to facilitate serving their customers in various geographical areas. The geographical areas are Asia-Pacific, Europe, North America, and South America. The number of Enterprises in each geographical zone will vary according to the markets served by Rhone-Poulenc, e.g. there are 11 Enterprises in Europe and 13 in North America. The Rare Earths and Gallium Enterprise is headed by J. D. Matthews, president, who is also in charge of the European zone, while the North-American zone managers are J. Forti and E. Haaijer. Mr. Matthews noted that "The effect of the reorganization on the rare earth business is relatively modest as it was already organized as a worldwide enterprise before the reorganization and remains as such. The key players remain the same .... The other chemical businesses are more fundamentally affected with a move towards market orientation to better serve customers."

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