Rare-earth Information Center INSIGHT

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

Volume 7 | August 1, 1994 | No. 8

Red Cerium Sulfide Pigment Moves Forward

One year ago in a **RIC Insight** (**6**, [8] August 1, 1993) exclusive, we reported that Rhône-Poulenc had developed a new environmentally friendly red pigment for coloring plastics. Recently, Rhône-Poulenc and Ferro Corp. announced that they have formed a cooperative agreement to evaluate the commercial prospects for the cerium sulfide. This joint study will determine the technical requirements, such as physical properties, colorant values, and performance for various markets by setting up testing programs with key customers. Pilot plant scale quantities of the pigment are expected to be available this fall. If the results of this study are positive, the two companies may form a joint venture to manufacture and market this pigment.

Cerium/Lutetium Oxysilicate Scintillator

Scientists at Schlumberger-Doll Research (Ridgefield, Connecticut) have discovered a new single crystal inorganic scintillator which has several advantages over existing scintillators. The new material is a cerium-doped lutetium oxyorthosilicate (LSO) and has the chemical formula $Lu_{2(1-x)}Ce_{2x}(SiO_4)O$. It has a scintillation emission intensity of ~75% that of NaI(Tl), a long time scintillation radiation detector. LSO has a scintillation decay time of ~40ns at a peak emission wavelength of 420nm. It has a high γ-ray detection efficiency because of its high density, $7.4g/cm^3$. LSO has an effective atomic number of 66, a radiation length of 1.12cm, and an index of refraction of 1.82. Because of this unique combination of properties (high emission intensity, speed, and both high density and effective atomic number), along with the facts that it is not hygroscopic and is rugged, LSO is an attractive candidate material for a variety of applications. These include medical imaging, such as x-ray and position emission tomography, geophysical exploration, nuclear and high energy detectors, and astrophysics. The single crystals were grown by the Czochralski technique under a continuous flow of N_2 gas containing 0.3% O_2 using an iridium crucible. The results were reported by C. L. Melcher and J. S. Schweitzer in **Nucl. Instr. Methods Phys. Res., A314**, 212-214 (1992), and in **U.S. Patent No. 4,958,080** (September 18, 1990).

Rare Earth Mineral Survey

An extensive and thorough report on rare earth minerals was recently released by the U.S. Geological Survey. This report, entitled "International Strategic Minerals Inventory Summary Report — Rare Earth Oxides", was prepared by W. D. Jackson and G. Christiansen of the U.S. Bureau of Mines. The objective of this report was to make publicly available, nonproprietary data and characteristics of major deposits of the rare earths. Also included is information on the operating and production status of the mines (both actual and potential annual production), and

- more -

Telephone: (515) 294-2272
Facsimile: (515) 294-3709

Telex: 283359
BITNET: RIC@ALISUVAX

the location and ownership of the world's processing plants. The report covers 123 rare earth deposits in 20 countries. The most are located in the United States (40), followed by Australia (35), Brazil (16), Canada and India (5 each), and China (4). The deposits have been classified as placers (58%) and hard-rock (42%). The placers occur most frequently in recent or ancient shorelines and, less frequently, along present or former riverbeds. The predominant mineral in the placers is monazite, except for Malaysia, where xenotime is the major mineral. The hard-rock deposits are the result of magmatic activity, except in Canada, where the rare earths are associated with secondary uranium.

At 96 of the these deposits monazite is the major rare earth mineral, while bastnasite is the main mineral at 11 of the sites. At the remaining 16 sites, the predominant mineral is allanite and brannerite (3 each), apatite and eudialyte (2 each), and one site each for anatase, davidite, florencite, gadolinite, perovskite and xenotime.

The authors conclude that rare earth resources, which are economically exploitable, are more than sufficient to meet the world's demand for the predictable future. About 52% of the 93.4 million metric tons of rare earth oxide equivalent are located in China. The remaining 48% are found in Namibia (22%), the United States (15%), Australia (6%) and India (3%). The primary production distribution, however, is 38% in China, 33% in the United States, 12% in Australia and 5% each in Malaysia and India. The data for this report were collected between October 1989 and June 1990, and so some of the above numbers do not reflect the current status. Uses and applications are also presented, but in some cases are wanting or out-of-date. Nevertheless, it is the best and most complete review of rare earth mineral resources available today, and it is a real bargain — it is available free from the U.S. Geological Survey, Map Distribution, Box 25286, MS306, Federal Center, Denver, CO 80225. Please ask for U.S. Geological Survey Circular 930-N, plus the title noted above.

Fluoride Antireflection Coatings

Rare earth fluorides, in particular NdF_3, GdF_3, and ErF_3, have been studied as antireflection coatings for silicon photoelectric devices by V. A. Rozhkov *et al.* [**Pis'ma Zh. Tekh. Fiz. 19**, 10 (1993); Engl. transl. **Tech. Phys. Lett. 19**, 606 (1993)]. The rare earth fluorides have a high transmittance in the 400 to 1100nm range of the light spectrum and thus are considered to be good candidates for such coatings. Fluoride films 80 to 110nm thick were prepared on a polished silicon, quartz and glass substrate by thermal deposition unto the heated substrate (T = 573K, 300°C). The light transmission varied from 96 to 99.5% depending on the wave length and the particular fluoride compound. The reflection of light from the fluoride coated surface ranged from about 2.0 to 5.6% over the spectral range of 400 to 927nm which is considerably less than the 30.6 to 44.3% for the uncoated silicon surface. These results show that the rare earth fluorides would be suitable antireflective coatings for silicon photoelectric devices. However, the rare earth oxides, even though they have a lower transparency than the fluorides, (85 to 98%) make better antireflection coatings, allowing only 0.01 to 0.07% of the light to be reflected from the silicon surface [see **RIC Insight 6** [1] (January 1, 1993)].

Karl A. Gschneidner, Jr.

K. A. Gschneidner, Jr.
Director, RIC