



Rare-earth Information Center **INSIGHT**

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

Volume 6

August 1, 1993

No. 8

Cerium Red for Plastics

Rhône-Poulenc recently announced that they have developed and patented a new family of red pigments for use in coloring plastics. The rare earth sulfides, in particular cerium sulfide, form the basis for this new family of pigments. Cerium sulfide, Ce_2S_3 , has a bright red color similar to cadmium sulfoselenide, one of the major red pigments used today for coloring plastics, in paints and coatings, and in ceramics. A variety of different red shades and hues can be obtained by modifying the synthesis process, and/or the composition, and/or the particle size.

The reflectance vs. wavelength for the Ce_2S_3 material is almost the same as that for the cadmium red pigment from 380 to 600 nm, and drops off slightly relative to the cadmium red for wavelengths greater than 600 nm. In comparison to cadmium red, Ce_2S_3 is better in lightfastness, is about the same in color, and is slightly lower in tint strength, hiding power and heat stability, but in all cases more than acceptable. Cerium sulfide was found to be easily dispersed, does not bleed and does not cause any warping.

Rhône-Poulenc has been working on these rare earth pigments for at least 8 years with a steady improvement in their properties as a red pigment. For example, since 1985 they have improved the lightness of Ce_2S_3 by 50%, while modifying the other color coordinates to get the desired color and shade. Particle sizes from under one to four microns are available. Most of the work has been done on the addition of Ce_2S_3 to polypropylene (PP), but the addition of these sulfide pigments in acrylonitrile-butadiene-styrene (ABS) and nylon have also been studied. The results were presented at the ANTEC 93 (Annual Technical Conference, sponsored by the Society for Plastic Engineers) meeting in New Orleans, May 9-13, 1993. Ultraviolet stability of Ce_2S_3 in PP is essentially the same as for cadmium red in either high humidity or normal atmospheric conditions. The thermal stability of the pigments is severely tested in the injection molding process, but even at the highest temperature, 300°C, the color variation in Ce_2S_3 -doped PP is not visually noticeable. However, under very aggressive injection conditions a small color modification can be observed due to a slight chemical instability of the Ce_2S_3 pigment. An addition of about 0.5% of Ce_2S_3 is sufficient to obtain the desired red color in PP. The process for preparing cerium sulfide and its exact composition have not been disclosed.

Because of environmental concerns, the pigment industry is searching for new materials to replace heavy metal-based pigments, such as cadmium sulfoselenide and lead molybdate. Although iron oxide is used as a red pigment, its color characteristics are sufficiently different, and it is not too likely to replace the cadmium red pigment. Because cerium sulfide possesses good

- more -

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

Telex: 283359
BITNET: RIC@ALISUVAX

thermal stability, lightfastness, opacity, hiding power and dispersibility, it is one of the most promising candidates for replacing the heavy metal pigments.

The plastic market is extremely large and accounts for 80 to 90% of the use of cadmium in pigments, with the other 10 to 20% divided among ceramics, and paints and coatings. In 1992 1700 metric tons (MT) of cadmium pigments were used in Europe and about half that (900 MT) in the United States. This development has the potential of being one of the large rare earth (cerium) markets in the late 1990's. The PP share of the plastics market is about 20% in both the United States and Europe, and about 30% in Japan.

Extraction Metallurgy

In late 1992 a comprehensive review of the state-of-the-art of the extractive metallurgy of the rare earths was published in *Intern. Mater. Rev.* **37**, [5], 197-248, and just became available to RIC. The paper was written by C. K. Gupta and N. Krishnamurthy from the Bhabha Atomic Research Centre, Trombay, Bombay. The topics covered by the authors are: rare earth resources, their chemical compositions and locations; world production; physical and chemical beneficiation; separation processes (chemical and physical, solvent extraction and ion exchange); metal preparation (metallothermic and electrolytic); metal purification (zone refining and electrotransport); preparation of alloys (primarily samarium-cobalt and neodymium-iron-boron permanent magnet materials); analytical techniques; and applications. In compiling this extensive review, the authors make reference to over 475 sources of information, which include many, if not all, the key papers in each of the above sections. It is a well-written article, and should be useful to both experienced rare earthers and neophytes to the rare earth field.

Improved High T_c Superconducting Thin Films

Thin films of $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ (YBCO) doped with silver and deposited on the $\langle 100 \rangle$ face of SrTiO_3 substrate have yielded large critical currents (J_c) at 77 K. D. Kumar and coworkers from the Indian Institute of Technology - Bombay and the Tata Institute of Fundamental Research, Bombay have found that the YBCO films doped with 5 wt.% Ag have the optimum superconducting properties with a critical current of $1.4 \times 10^7 \text{ A/cm}^2$ at 77 K, which according to the authors is as good or better than the best reported J_c values with undoped YBCO films [*Appl. Phys. Letters*, **62**, 3522 (1993)]. The films were grown in situ by laser ablation of the Ag-doped YBCO to form films on $\langle 100 \rangle$ LaAlO_3 and $\langle 100 \rangle$ SrTiO_3 substrates at 700°C . The film thicknesses varied from 1000 to 2000 Å. The best results were obtained using the SrTiO_3 substrates. According to the authors, the improved J_c is due to grain enlargement and alignment caused by the silver dopant. The availability of active oxygen at the growth surface, as well as enhanced surface mobility, both of which are due to silver, are presumed to be the major mechanism for the improvements in the microstructure and J_c of the silver-doped YBCO.

Karl A. Gschneidner, Jr.
K. A. Gschneidner, Jr.
Director, RIC