RARE-EARTH INFORMATION CENTER NEWS

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Several Aspects of

Less X-Ray Exposure

—Understanding—

The U. S. Department of Health, Education and Welfare estimates that diagnostic medical x-ray use constitutes the largest single source of radiation exposure to the U.S. population. Rare earth phosphor x-ray intensifying screens offer the possibility of reducing that exposure by up to 50%. Along this line, A. F. Sklensky, R. A. Buchanan, T. G. Maple and H. N. Bailey have reported the dependence of the speed and resolution of radiographs which employ rare earth oxysulfide intensifying screens on several parameters involved in manufacturing the screens [*J. Electrochem. Soc.* **122,** 1089-92 (1975)]. The parameters examined included screen thickness, dye concentration of the binder, the use of a diffusely reflecting layer between the phosphor coating and substrate, packing density of the phosphor particles, the wavelength of light emitted by the phosphor and the use of two screens and a double-coated film instead of a single screen and single-coated film. For most of the parameters there was a trade-off between speed and resolution. An exception is high phosphor packing density which appears to increase speed with little or no sacrifice of resolution. There was also a speed advantage in using green-sensitive film for gadolinium and lanthanum oxysulfide phosphors. The remaining parameters required a significant trade-off between exposure and resolution.

—Comparison—

R. F. Wagner and K. E. Weaver have compared the speed, mottle (system noise) and quantum efficiency of several rare earth screen-film systems with conventional screens [*Radiology* **118**, 183-8 (1976)]. The fastest rare earth systems tested showed a large speed advantage but also had a corresponding increase in noise. However some of the slower rare earth systems proved to be comparable in noise to the conventional systems but with a 50% reduction in x-ray exposure. The authors suggest that adding dyes to the phosphors or the use of a less sensitive film could result in improved resolution.

—Invention—

A. P. D'Silva and V. A. Fassel have been awarded U.S. Patent No. 3,925,674 (Dec. 9, 1975) on an improved x-ray image intensifier phosphor consisting of an yttrium-gadolinium-terbium phosphate. They discovered that adding only a small amount of terbium to $Y_{1-x}Gd_xPO_4$ shifted the spectral emission into the violet-blue region and made the phosphor more sensitive to x-ray radiation than currently used phosphors. In addition to use as an x-ray screen, application can be made in the optical detection of nuclear radiation.

—R. E. Industry—

Year-end statistics assembled by Molycorp, Inc. show a dramatic increase in the use of gadolinium and lanthanum in phosphor screens for intensifying x-ray images. Figures on western world usage show 40 thousand pounds of the two materials were used for x-ray

(continued on page 3)

EXTRATERRESTRIAL RE'S

Now You See Them. . .

I wonder how many rare earthers around the world have been out for an afternoon walk and suddenly been struck by the question, "How much of this lovely sunshine is attributable to the rare earth content of the sun?" A difficult question to answer (mostly because of pride). However, thanks to J. E. Ross and L. H. Aller, one can at least know the sun's rare earth compositions relative to hydrogen except for promethium, terbium and holmium [*Science* **191,** 1223-9 (1976)]. Individual conclusions can then be reached.

Concerning rare earths in solar phenomena, W. V. Boynton has proposed a model for fractionation in the solar nebula and predicts the condensation of yttrium and the rare earth elements [*Geochim. et Cosmochim. Acta* **39**, 569-84 (1975)]. The model is consistent with known thermodynamic data of the rare earth oxides and reasonable assumptions concerning non-ideal solid solution formation. Boynton suggests that rare earth condensation is determined by thermodynamic equilibrium between gas and condensed solids, occurs over a wide temperature range and does not vary regularly with atomic number.

A Ca-Al-rich inclusion from the Allende meteorite has been analyzed and its rare earth element abundances coincided well with the theory's description of a condensate from a previously fractionated gas rather than from a gas of solar composition. The author believes that

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MEETING

12th RE Conference

July 18 is getting closer and closer and the excitement is starting to mount as the 12th Rare Earth Research Conference begins to take shape. Sessions will be held on magnetics, general and coordination chemistry, bioinorganics, intermetallics, spectroscopy, solid state, metallurgy, technology in action, and solid state physics. A complete listing of the invited speakers and their topics appears below.

Magnetic Moment Densities in Rare Earth Metals and Compounds, W. C. Koehler.
Some Crystal Field Effects on the Magnetic Behavior of 4f-3d Intermetallic Compounds, R. Lemaire.
Factors in the Complexation of Lanthanides, G. R. Choppin.
Lanthanides as Probes in Immunoglobulin Systems, D. R. Burton.
Catalytic Activities of Rare Earth Intermetallics, T. Takeshita.
Nonresonant Energy Transfer Interactions Between Randomly Distributed Guest Molecules in Host Lattices, F. K. Fong.
Ligand-Field Parameters for Eu^{3+} in YMO_4 (M = V, P and As), F. Gaume.
Reduced Halides of the Rare-Earth Elements, J. D. Corbett.
Mixed Valence Rare Earth Halides and Their Unusual Crystal Structures, H. Barnighausen.
High Resolution Lattice-Imaging of Rare Earth Sesquioxides, P. Caro.
Rare Earths—A Growth Industry, D. A. Hukin.
Single Crystal Growth of Rare Earth Intermetallic Compounds, J. B. Milstein.
Solid State Chemistry and Physics of the Monopnictides and Monochalcogenides of Some Trivalent Rare Earths, E. Kaldis.
Electrotransport of Solutes in Rare Earth Metals, O. N. Carlson and F. A. Schmidt.
Availability of Rare Earths to Industry, J. A. Jolly.
Fabrication and Utility of Unusual Rare Earth Compounds, E. Colton.
On the Heat of Formation of Solid and Liquid Alloys of Transition Metals, A. R. Miedema.

CeP_5O_{14} Scintillator

D. Bimberg, D. J. Robbins, D. R. Wight and J. P. Jeser report what they believe to be the fastest cerium-activated phosphor known to date in *Appl. Phys. Letters* **27**, 67-8 (1975). Cathodoluminescence spectra of CeP_5O_{14} reveal a strong ultraviolet emission, ultrafast decay rate and minimal afterglow. These characteristics earmark CeP_5O_{14} for applications as a fast scintillator including use as a beam-indexing phosphor for color television and as an electron detector for scanning electron microscopes (SEM). Additional advantages of CeP_5O_{14} in the SEM application are good resistance to beam damage and availability in single crystal form.

International Conference on Valence Instabilities

An International Conference on Valence Instabilities and Related Narrow Band Phenomena will be held at the University of Rochester, Rochester, New York, on November 12-13, 1976. The purpose of the conference is to stimulate exchange between scientists who are either theoretically or experimentally studying the problems of non-integral valence, valence instabilities and related narrow-band phenomena and to consolidate and correlate current knowledge in the field.

Mixed-valence compounds are of widespread interest in relation to studies of the Kondo problem, magnetic properties, excitonic-like and electro-elastic effects. They are of special interest to rare earthers because many alloys and compounds of cerium, samarium, europium, thulium and ytterbium exhibit valence instabilities.

The Conference will consist of approximately 25 invited talks. The invited speakers will be chosen by the organizing committee consisting of P. W. Anderson (Bell Laboratories), S. Doniach (Stanford/Orsay), R. D. Parks (Rochester) and T. Penny (IBM). The conference is open to anyone who wishes to attend. The pr9ceedings will probably be published as an *A.I.P. Conference Proceedings.*

RE MAGNET MOTORS

Rare earth-cobalt permanent magnets are threatening to turn the dc motor technology inside-out, literally, according to J. M. Brown, [*Control Eng.* **22**, [10], 99-100 (1975)].

The advantages offered by the rare earth magnets include improved permanent magnet properties, an 8:1 ratio of better magnet volumetric efficiency, less fringing of the magnetic path providing more flux which results in higher torque, less rotor inertia allowing for greater angular acceleration capabilities, and low flux loss at higher temperatures.

The major disadvantage of the conventional motor design is heat build-up in the wire-wound central rotating member. Now it is possible to place the magnet on the rotor and wind the wires along the outside of the motor thus allowing for the easy removal of heat build-up in the wires. As always, each break through leads to another problem. For dc motors it is the problem of comminuation. Although several solutions are being researched they are generally expensive and inefficient. Despite these problems, the rare earth-cobalt permanent magnets appear destined to revolutionize the dc motor.

RE's in the News

Hydrogen Storage

Researchers at Lawrence Livermore Laboratory have developed a lanthanum cobalt alloy capable of absorbing nine hydrogen atoms per molecule at a pressure of 1300 atm of hydrogen. However cost and thermodynamic considerations indicate this alloy will have more use in studies on the understanding of hydrogen absorption in alloys than in commerical application.

Completes Plant Expansion

Molycorp's new 200 ton-per-day bastnasite thickening/filtering/drying section at their Mountain-Pass, California, location began processing material in January of this year and the lanthanum concentrate dryer has become fully operational.

X-RAY (continued from page 1)

screens in 1975 compared to 16 thousand in 1974 and just 4 thousand in 1973.

X-ray screen image intensification is considered as the most important new development in the commercial use of rare earth phosphors since the 1960's when rare earth phosphors were developed for color television tubes. It is estimated that x-ray systems account for 20% of total rare earth phosphor consumption while only 10% of the x-ray screen market has been captured by the new rare earth phosphor screens.

Hold That Plot!

Were you finally getting used to those lanthanide curiosities which include the gadolinium break, tetrad and double-double effects? Well, S. P. Sinha has just introduced the "inclined W" plot [*Helv. Chim. Acta* **58**, 1978-83 (1975)]. The "included W" plot results when properties such as oxidation potential, stability constants, M-N stretching frequencies and lattice parameters of the lanthanide ions and complexes are plotted against the total angular momentum (L) of the individual rare earth elements. L varies nonlinearly within the series and divides it into four groups: La-Nd, Pm-Gd, Gd-Ho, and Er-Lu. While not all of the properties graphed exhibit the inclined W form, the linearity within each of the four groups in the series was preserved.

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Address Changes

Cerac has moved to a new location: 407 No. 13th Street, Milwaukee, WI 53233. Correspondence should be addressed to: P.O. Box 1178, Milwaukee, WI 53201. Their new telephone number is (414) 289-9800.

Atomergic Chemetals Corporation moved to their new address at 100 Fairchild Avenue, Plainview, N.Y. 11803 in January of this year. Their telephone number is (516) 822-8800.

Both Cerac and Atomergic Chemetals Corp. are manufacturers of specialty chemicals including many rare earth materials.

CO To CO_2

In a search for an active and stable perovskite catalyst which can be prepared by relatively inexpensive ceramic techniques P. K. Gallagher, D. W. Johnson, Jr., J. P. Remeika, F. Schrey, L. E. Trimble, E. M. Vogel and R. J. H. Voorhoeve have undertaken a study of $La_{0.7}Sr_{0.3}MnO_3$ and $La_{0.7}Pb_{0.3}MnO_3$ as catalysts for the oxidation of CO to CO_2 [*Mat. Res. Bull.* **10**, 529-38 and 623-8 (1975)].

$La_{0.7}Sr_{0.3}MnO_3$ showed high catalytic activity initially and was stable when heated to temperatures greater than 1000°C due to the low mobility of Sr. 60% of its catalytic activity was retained at the elevated temperatures. Supported devices of this material exhibited overall activities comparable to commercial platinum catalysts.

Freshly prepared $La_{0.7}Pb_{0.3}MnO_3$ also showed good catalytic activity at first however this material proved susceptible to deactivation at relatively low temperatures due to migration of lead to the catalyst surface. Introduction of platinum at concentrations from 2200 to 5500 ppm into the samples significantly increased the catalytic activity.

The effect of platinum concentration in $La_{0.7}Pb_{0.3}MnO_3$ on the catalytic oxidation of CO to CO_2 in the presence of SO_2 was also examined. As little as 200 ppm Pt dramatically increased the resistance of the catalyst to SO_2 poisoning. In addition the catalytic activity under these conditions increased with increasing platinum content. The authors also note that these catalysts require significantly less platinum than catalysts which contain noble metals as the active element.

CONTRIBUTORS

Four contributions were received in the final quarter of Fiscal Year 1976 from Colt Industries, Crucible Materials Research Center, U.S.A. and Industrial Minera Mexico, S.A. (formerly Asarco Mexicana, S.A.), Mexico, each contributing for the second year, GTE Laboratories, Inc., U.S.A., a four time contributor, and from Santoku Metal Industry Co., Ltd., Japan, who has donated to the Center for six years.

A total of 34 companies came to the support of RIC in a year that started out rather gloomily for the business community. Economic indicators seem to be on the upswing finally and it is our sincere hope that 1976 will be a prosperous year for the rare earth industry.

Asymmetric Scattering

Asymmetric scattering of electrons in metals has been reviewed by C. M. Hurd in *Contemp. Phys.* **16**, 517-32 (1975). Asymmetric scattering arises because the scattered electron has an unequal probability of passing on one side of the scattering ion rather than to the other side. The microscopic origins of the asymmetric scattering of itinerant electrons are characterized and recent developments of their macroscopic manifestations are discussed. Theoretical considerations include description of an itinerant electron, intrinsic spin-orbit coupling, asymmetric nonresonant scattering, asymmetric resonant scattering and the jump effect. Discussion centers around the anomalous hall effect in gadolinium metal and for cerium dissolved in lanthanum as an example of a partially filled virtual level, and trivalent rare earth ions dissolved in noble metals as an example of a completely filled virtual level. Hurd notes that there is much experimental work yet to be done before any of the theoretical speculations can be given a firm foundation.

EX-REs (cont. from p. 1)
prior to the condensatuon of the Ca-Al-rich inclusion, another condensate was formed and then removed from equilibrium with the gas. This model differs from the assumption of a cosmic composition in total equilibrium with all condensed solids.

. . .And Now You Don't!!!

The absense of rare earth enrichment in one mineral fraction of the Allende meteorite has added strength to the findings of Dr. E. Anders of the University of Chicago's Enrico Fermi Institute [*Science* **190**, 1251 (1975)]. Anders believes the mineral contains the decay products of a super heavy element, possible 113, 114 or 115, which was present in the solar nebula over 4 billion years ago. The main support comes from the existence of a peculiar isotopic composition of xenon. In addition, analysis of the mineral for at least one cogener of each of the super heavy elements between 107 and 120 revealed enrichment of bismuth and thallium instead of the rare earths, uranium or noble metals. According to Anders this evidence points to elements 113, 114 or 115 as the most likely parent material.

ESR REVIEW

The need for a comprehensive directory of electron spin resonance (ESR) studies and a general assessment of the scope and limitations of the ESR technique were cited as reasons for the publication of "Electron Spin Resonance of Magnetic Ions in Metals—An Experimental Review" by R. H. Taylor [*Adv. in Phys.* **24**, 681-791 (1975)].

The history, theory and application of ESR to the understanding of exchange interactions, RKKY interactions, the ESR bottleneck, valence states, crystal field effects, fine and hyperfine structure, magnetic ordering, superconductivity and the Kondo effect are discussed. Metals and compounds containing rare earths as impurities and rare earth intermetallic compounds are mentioned frequently in the review of experimental results. Finally, future directions for the application of ESR techniques are noted. An Appendix lists references which are cross-referenced with respect to authors, impurities, hosts and general subject material.

TRICHLORIDE LASER

Room temperature cw Nd^{3+}:$CeCl_3$ laser emission has been reported by S. Singh, R. B. Chesler, W. H. Grodkiewicz, J. R. Potopowicz and L. G. Van Uitert [*J. Appl. Phys.* **46**, 436-8 (1975)]. Laser operation was achieved at a pump threshold 0.6 times lower than for the most widely used solid state laser, Nd^{3+}:YAG. This value agrees well with theoretical predictions for Nd^{3+}:$CeCl_3$.

In an earlier communication [*Appl. Phys. Letters* **24**, 10-3 (1974)] Singh, Van Uitert, Potopowicz and Grodkiewicz noted that stronger pump bands and higher laser transition cross sections made neodymium doped anhydrous cerium trichloride a very likely candidate for miniaturized and thin film laser applications in fiber-optic communications systems. The authors predict that with improved preparation and processing techniques Nd^{3+}:$CeCl_3$ could soon be offered as a viable alternative to conventional materials.

MM Rivals La

Recent hydrogen storage studies by C. Lundin and F. Lynch of the Denver Research Institute, University of Denver, involved a cerium-free $MMNi_5$ alloy which showed characteristics similar to $LaNi_5$. The favorable reaction kinetics, contamination resistance, relatively flat plateaus, and small hysteresis plus the lower cost of cerium-free mischmetal makes $MMNi_5$ an attractive alternate to currently known materials, e.g. $LaNi_5$.

G. V. Samsonov Dies

RIC has received word of the death of G. V. Samsonov on December 22, 1975 at the age of 58. Samsonov graduated from the Moscow Institute of Chemical Technology in 1940. His graduate work on the metallurgy of the rare earths was completed at the Moscow Institute of Nonferrous Metals in 1950. He remained with this Institute until 1956 when he then became associated with the Institute of Material Science Problems of the Ukranian Academy of Sciences as a Division Head until 1961 when he then became Deputy Director of the Institute of Research. Samsonov, a corresponding member of the Ukranian Academy of Sciences was mainly interested in refractory compounds and received several awards for his research. He authored several books and many articles on refractory materials, including rare earth sulfides, oxides, borides and carbides.

RIC-DD Acquisitions

RIC-DD-15 **Atomic Energy Levels, Isoelectronic Series $2p^N$, $3p^N$, $4p^N$ and $3d^N$** by J. Karwowski, K. M. S. Saxena, B. Bray and S. Fraga (1975) 59 pp (U.S. $5.90) [Airmail Rate B]. (Editors Note: Scandium is the only rare earth covered in this document.)

RIC-DD-16 **Atomic Energy Levels, Isoelectronic Series $3d^8$, $4p^N$, $4d^N$, $5p^N$, $4f^N$, $5d^N$, $6p^N$ and $5f^N$** by K. M. S. Saxena, J. Karwowski and S. Fraga (1976) 226 pp (U.S. $22.60) [Airmail Rate C].

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