



# RARE-EARTH INFORMATION CENTER NEWS

ENERGY AND MINERAL RESOURCES RESEARCH INSTITUTE  
IOWA STATE UNIVERSITY / AMES, IOWA

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March 1, 1986

No. 1

## RE's in the News New Permanent Magnet

A new entrant in the high-performance permanent magnet market was announced at a news conference in early 1986 by Ovonic Synthetic Materials Company, Incorporated (OMC), of Troy, Michigan, U.S.A. The subsidiary of Energy Conversion Devices, Incorporated (ECD), said they expect their new Ovonic Hi-Rem magnet to capture a large share of the high-performance market.

At the news conference, Stanford R. Ovshinsky and Julius J. Harwood, presidents of ECD and OSMC, respectively, claimed the performance/cost ratio of the new magnet will be twice as good as the old samarium-cobalt magnets or the new neodymium-iron-boron magnets. The magnets are said to be up to 10 times more powerful than ferrite magnets.

OSMC is seeking patent protection on the material (a rare earth-iron alloy) and its production process. The process makes magnetic powder by spin melting and the powder is then fabricated into magnet shapes by simplified forming. A key property that allows the simplified forming is the isotropicity of the powder. The powder particles show, according to the claims made, high performance properties in all directions and need no costly particle alignment steps in their processing. Pilot production is under way, samples are under test by some potential users, and full production is expected in 1987.

### Hydrogen Recycling Nuclear Reactors

Ergenics, Incorporated, of Wyckoff, New Jersey, has announced, according to their news release, a major breakthrough in recycling hydrogen that will substantially reduce operational costs of boiling water nuclear

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## FRANK H. SPEDDING AWARD WINNERS



Allan R. Mackintosh



Hans Bjerrum Møller

Professor Allan R. Mackintosh and Dr. Hans Bjerrum Møller have been named to share the 4th Frank H. Spedding Award by the Rare Earth Research Conference (RERC). They will be presented the award during opening ceremonies of the 17th RERC to be held June 8-12, 1986, in Hamilton, Ontario, Canada. As a result of a fortuitous coincidence, the first honorees chosen since the death of Dr. Spedding will, appropriately enough, be honored in the town of his birth.

Drs. Mackintosh and Møller were nominated for their pioneering contributions to the understanding of magnetic excitations and interactions in rare earth metals. Building upon the foundations established by the winners of the 3rd Spedding Award, Drs. Legvold and Koehler [*RIC News*, XVIII [2] 1 (1983)], they extended and broadened the knowledge base through the present time. Working both separately and together, Drs. Mackintosh and Møller have made many important contributions to rare earth research. In particular their pioneering studies of the spin waves in terbium by inelastic neutron scattering resulted in a revolutionary improvement in our understanding of magnetic interac-

tions and properties of the heavy rare earths. Their subsequent studies of praseodymium, which behaves differently, did the same for the light rare earths.

Dr. Allen Mackintosh, a resident of Denmark for some 20 years, was born and educated in the United Kingdom. He received his Ph.D. from the University of Cambridge in 1960 and began a six year association with the Iowa State University Department of Physics. He became interested in the rare earths and in collaboration with others, explored or proposed new concepts on magnetic superzones, electronic structure by positron annihilation, and transport properties. He spent 1963-64 at the Risø Re-

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## PROCEEDINGS

### IREC 85—ZURICH

Elsevier Sequoia S.A. has published the proceedings (45 invited and 108 contributed papers) of the International Rare Earth Conference held March 4-8, 1985, in Zurich, Switzerland, as volumes 110, 111, and 112, of *Journal of the Less-Common Metals*. The editors, Jean-Claude G. Bünzli, John E. Greedan, and Fritz Hullinger, tried to group the papers thematically under seven subject headings, but as they state in the preface, "We realize that we probably did not succeed in every case."

Volume 110 includes 23 papers grouped under the subject heading "Thermodynamics and Phase Diagrams" and 32 papers under the heading "Material Synthesis, Structural and Physical Properties."

Volume 111 has 6 papers in "Technology and Industrial Applications," 19 under "Magnetic Materials, Magnetic Properties," and 26 entries dealing with "Physical Properties, Electronic Properties."

Volume 112 has 19 papers in the section dealing with "Optical Properties" and 28 in the section "Organometallic, Coordination, Solution, and Bioinorganic Chemistry."

As the title implies and the subject headings indicate, this conference covers, with the exception of possible nuclear reactions, almost any field involving rare earths. Volumes 110, 111, and 112 are available as hard cover books containing 453, 382, and 418 pages, respectively, and were published in 1985. The set is available for U.S.\$268.00 and may be ordered from Elsevier Sequoia S.A., P.O. Box 851, 1001 Lausanne 1, Switzerland, or from Elsevier Science Publishers, 52 Vanderbilt Avenue, New York, N.Y. 10017, U.S.A.

### Present-Future Nd-Fe Magnets

*Nd-Fe Permanent Magnets: Their Present and Future Applications* is the title of the proceedings of a workshop organized by the Commission of the European Communities Directorate-General for Science, Research and Development. The workshop was held October 24, 1985, in Brussels, Belgium.

Edited by I. V. Mitchell, the 270-

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page book costs U.S.\$53.00 and was published in 1985 by Elsevier Press. In the U.S.A. and Canada, contact Elsevier Science Publishing Co., Inc., 52 Vanderbilt Avenue, New York, N.Y. 10017. Elsewhere, purchasers should contact Elsevier Applied Science Publishers Ltd., 19 Arbemarle Street, London W1X 3HA, England.

The book consists of seven chapters dealing with different aspects of the permanent magnet field in which the Nd-Fe-B magnets are playing an ever increasing part. The various chapters present (1) an introduction to permanent magnets, (2) the economics and availability of raw materials and magnet ingredients, (3) the processing and physical metallurgy of magnetic alloys, (4) a comparison of the properties of Nd-Fe-B and Sm-Co magnets, (5) the crystal chemistry and physical magnetic properties of R-Fe-B alloys and compounds, (6) the present and potential applications of permanent magnets, and (7) the patent situation as of October 1984.

### Heavy Fermions

The proceedings of the 8th Taniguchi Symposium on the Theory of Condensed Matter held April 10-13, 1985, in Shima Kanko, Japan, has been published as volume 62 in the Springer Series in Solid-State Sciences. Entitled *Theory of Heavy Fermions and Valence Fluctuations*, the 287-page book is edited by T. Kasuya and T. Saso. It was published by Springer-Verlag in Germany in 1985 and costs U.S.\$27.50. It can be obtained from Springer-Verlag, Heidelberger Platz 3, D-1000 Berlin 33, West Germany, or from Springer-Verlag, New York Inc., 175 Fifth Avenue, New York, N.Y. 10010, U.S.A.

This book contains the following materials. First, a brief review of the experimental results and interpretations for valence fluctuation phenomena is given, followed by fundamental considerations of the various aspects of the important interactions—the *d-f* Coulomb and the *c-f* mixing interactions. Next is a review of the experimental situations for heavy Fermion superconductivity as well as the possibility for new kinds of exotic superconductors from the experimental point of view. The results of the exact solution of the single-site Kondo problem are reviewed

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## CARBON CLUSTERS

When you focus a laser beam of sufficient power on a solid surface, you cause clusters of the solid to evaporate. If the plasma created is hot enough, you can also ionize these clusters or they can be swept away in a moving gas stream and ionized by some other means. Dr. Richard E. Smalley and his co-workers at Rice University in Houston, Texas, have applied the laser evaporation technique to the study of carbon. They have observed clusters of carbon atoms containing more than 76 atoms. Only clusters with even numbers of carbon atoms are observed at these higher molecular weights. Especially stable is the  $C_{60}$  cluster, which they give the somewhat fanciful name "Buckminsterfullerene" in honor of Buckminster Fuller's pioneering studies into polygonal structures. They believe it to be a spheroidal, aromatic molecule in the form of a truncated icosahedron—a polygon with 60 vertices and 32 faces (12 pentagons and 20 hexagons). Each carbon atom is involved in two single bonds and a double bond with other carbon atoms.

This structure is best represented by the modern day soccer ball. This "soccer ball" structure contains a central cavity that should be an exceptionally strong binding site for a wide range of even quite large atoms. In *J. Amer. Chem. Soc.*, 107, 7779-80 (1985), Dr. Smalley and his co-workers report the formation of a stable  $C_{60}La$  complex and give as evidence the time-of-flight mass spectrum of the  $C_nLa$  complexes with *n* from 44 to 76. The authors believe  $C_{60}La$  and possibly  $C_{70}La$  to be quite stable—as would be expected if these  $C_n$  species surround the metal atom much as an egg white and shell surround the yolk.

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in the next section. The exact solution is limited to the static properties. Various studies on dynamical transport, optical properties, and neutron scattering are treated by approximation schemes in the next few chapters. This is followed by some preliminary work on the Kondo lattice state and finally the possibility of new exotic superconductivity in the heavy Fermion systems is discussed from the theoretical point of view.

## Data Card Errata

In *RIC News*, XX, [3] 4 (1985) we announced the availability of a rare earth data card from North-Holland, the publisher of *Handbook on the Physics and Chemistry of Rare Earths*. The data on the cards were taken from the *Handbook* but, regrettably, the values for the boiling point of Eu, the heat of sublimation of Eu, and the melting point of Tb are in error. North-Holland mailed out many cards in answer to your requests. The cards have been reprinted with the correct information. If your card does not have a 10 1985/2 on the side with the basic physical properties listed, your card is in error. Please destroy the card and again contact Ms. C. Schilpp, Marketing Manager, North-Holland Physics Publishing Co., P.O. Box 103, 1000 AC Amsterdam, The Netherlands. They will be happy to send you a new and correct card.

### In the News

(Continued from page 1)  
reactors.

They also announced they have signed an exclusive license agreement with Koch Process Incorporated of Westborough, Massachusetts, to manufacture and market the new technology, known as the Ergenics-Koch Process. Koch will sell the process in the United States, Canada, Mexico, Japan, and Taiwan. They estimate the process will save \$300,000 per year in hydrogen needed for a boiling water nuclear reactor by capturing and recycling 85 percent of the hydrogen that previously escaped and had to be replaced.

### Tiny Laboratory "Star"

Scientists at the Lawrence Livermore National Laboratory, using the giant "Nova" battery of lasers, came close to duplicating the temperatures and pressures found at the center of stars. "We made a tiny little star," said Erik Storm, director of Livermore's Inertial Confinement Fusion Program.

For a billionth of a second, the laser system poured 100 trillion watts into a tiny sphere of deuterium and tritium. They estimate the temperatures reached 30 million degrees in less than 50 trillionths of a second. At these temperatures and pressures, fusion occurs to produce he-

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## AMERICAN PHYSICAL SOCIETY'S AWARD FOR NEW MATERIALS AWARDED TO FOUR



John Croat

Jan Herbst

Norman Koon

Masato Sagawa

Drs. John J. Croat, Jan Herbst, Norman C. Koon, and Masato Sagawa were announced as winners of the American Physical Society's International Prize for New Materials. They will be awarded their prize in a ceremony in their honor at the March APS meeting to be held in Las Vegas, Nevada, U.S.A. from March 31 to April 4, 1986. The four will split the \$5,000 honorarium and each will be awarded a certificate on which their name and citation are inscribed.

The citation that the Prize Committee composed reads as follows, "For their pioneering research on the preparation and characterization of rare earth-iron-boron materials which led to the discovery of a new class of permanent magnets of unusual scientific interest and technological promise."

Dr. Croat is with the Delco-Remy Division of the General Motors Corporation in Anderson, Indiana. He formerly worked with Dr. Herbst in the Physics Department of the General Motors Research Laboratories in Warren, Michigan. Dr. Koon is with

the Naval Research Laboratory in Washington, District of Columbia, U.S.A., while Dr. Sagawa is associated with Sumitomo Special Metals Company, Limited, in Osaka, Japan.

The RIC would like to extend our congratulations to these four for winning this award. We would also like to extend our thanks to all the other scientists who have made this field so interesting in the past four years. We are sure the four winners would be the first to say, "It is too bad you could not all be recognized with us."

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lithium and energy. It was estimated that the energy created was twice that of the entire electric generating capacity of the United States. The test was the latest in science's search for a way to make cheap electricity through fusion energy.

### Thermal Hydride Engine

In a recent news release Ergenics Incorporated announced the development of a 300-watt thermal engine that needs no external electric power. They propose its use as a means of pumping water for arid countries. They claim it can pump 10 gallons of water per minute from a well 50 feet deep. It will be tried in Mexico and Texas where the SerVaas Group is setting up a distribution network. Ergenics is working to set up other distribution systems in other places that are arid or are subject to periodic

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droughts. The engine is said to be inexpensive, adaptable to any standard pump, easily installed, and able to operate unattended. The same Ergenics hydride system can be used to purify water by reverse osmosis, to produce refrigeration, and to generate electricity.

### Magnetic Research in Europe

The European Commission Directorate for Science is supporting, with a sum of 2.5 million ECU, a rather large collaborative project on rare earth permanent magnets entitled "Concerted European Action on Magnets" (CEAM). Scientists from some 53 laboratories in nine countries will be involved in CEAM. Their goal is the production and application of new, high-performance, rare earth-transition metal permanent magnets. The project got under way

(Continued on page 4)

## MEETINGS

### 3rd ICPMM

(Change in Time and Place)

The dates of the 3rd International Conference on Physics of Magnetic Materials has been changed to September 9-14, 1986. It will be held in Szczyrk-Bila, Poland, rather than in Spala as announced in the December 1, 1985, issue of *RIC News*. The reason for the change in dates is to allow scientists to attend this conference and also the XXIII Congress Ampere on Magnetic Resonance to be held September 15-19, 1986, in Rome, Italy. For more information, contact Dr. Henryk K. Lachowicz (chairman) or Dr. Danuta Zymierska (secretary), Organizing Committee 3rd ICPMM, Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland.

### ISMIC

An International Symposium on Magnetism of Intermetallic Compounds will be held April 20-22, 1987, in Kyoto, Japan. This is a satellite meeting of INTERMAG '87, which is to be held April 14-17, 1987, in Tokyo.

The symposium will cover basic magnetism of intermetallic compounds of rare earths, actinides, and transition metals. Possible topics include magnetic structures and ordering, spin fluctuation effects, anisotropy and magnetostriction, transport and thermal properties, and electronic structures. The program will include invited talks as well as submitted papers presented orally or in poster sessions.

For more information contact Professor Y. Nakamura, Chairman of Organizing Committee ISMIC, Department of Metal Science and Technology, Kyoto University, Sakyo-ku, Kyoto 606, Japan.

### 9th REPM Workshop

A technical conference, the 9th International Workshop on Rare-Earth Permanent Magnets (REPM) and Their Applications will be held from August 31 to September 2, 1987, in Bad Soden, West Germany. In con-

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(Continued from previous column) junction with the workshop, the 5th International Symposium on Magnetic Anisotropy and Coercivity in Rare Earth-Transition Metal Alloys will be held September 3 to deal with basic scientific questions. In keeping with the practice started with the 8th REPM Workshop, the word cobalt was dropped from the official name to indicate the widening use of other magnetic materials containing rare earths.

The REPM workshop will deal with a wide spectrum of topics and problems of a technological and business nature relating to magnetic materials and their uses as magnets in motors, medicine, transportation, robotics, etc. The symposium held the last day of the meeting will include topics on the physics of magnetic anisotropy, coercivity of magnetic materials, the mechanisms controlling magnetic reversal and the stability of magnets. All papers must be written and presented in English. The proceedings will be ready for distribution to registrants and available for purchase later.

For more information, contact Dr. Rainer Poerschke, Hauptstrasse 5, D-5340 Bad Honnef 1, West Germany [Telephone (022 24) 7 1061]. To get on the mailing list you can also contact Dr. Karl J. Strnat, KL-365, University of Dayton, Dayton, Ohio 45461.

### Russian Acquisition

The RIC has recently received a copy of *Sintez i Svoistva Soedinenii Redkozemel'nykh Elementov* (Synthesis and Properties of Compounds of the Rare Earth Elements). The 160-page book is edited by V. G. Bamburov and was published in 1982 by Akademiya Nauk SSSR, Uralskii Nauchnyi Tsentr, Sverolovsk. The book includes 20 papers by various authors. The topics include europium chalcogenides and fluorides; solid solutions of EuO with other metallic cations; variable valence of mixed rare earth sulfides; phase diagrams of Eu, Gd, and Ho with indium;  $RB_{66}$  borides (with R = Sm, Gd, or Yb);  $Lu_2V_2O_7$  and  $Yb_2V_2O_7$ ; terbium oxide thin films; magnetic susceptibility of rare earth metals at high temperatures; magnetism and energy bands in the La-S system; and electron structure of rare earth oxyfluorides.

## CONFERENCE CALENDAR

5th Intl. Symposium on the Properties and Applications of Metal Hydrides  
Maubisson, France  
May 25-30, 1986  
*RIC News*, XX [3] 1 (1985)

17th Rare Earth Research Conference (RERC)  
Hamilton, Ontario, Canada  
June 8-12, 1986  
*RIC News*, XIX, [2] 3 (1984) and XX [1] 3 (1985)

Intl. Conf. on Anomalous Rare Earths and Actinides (I.C.A.R.E.A.)  
Grenoble, France  
July 7-11, 1986  
*RIC News*, XX [2] 2 (1985)

3rd Intl. Conf. on Physics of Magnetic Materials (ICPMM)  
Szczyrk-Bila, Poland  
September 9-14, 1986  
\*This issue and *RIC News*, XX [4] 3 (1985)

5th Intl. Conf. on Valence Fluctuation  
Bangalore, India  
January 5-9, 1987  
*RIC News*, XX [4] 3 (1985)

2nd Intl. Conf. on the Basic and Applied Chemistry of the *f*-Transition (Lanthanide and Actinide) and Related Elements (2nd I.C.L.A.)  
Lisbon, Portugal  
April 6-10, 1987  
*RIC News*, XIX, [4] 3 (1984) and XX [2] 2 (1985)

Intl. Symposium on Magnetism of Intermetallic Compounds (ISMIC)  
Kyoto, Japan  
April 20-22, 1987  
\*This issue

9th Intl. Workshop on Rare-Earth Magnets and Their Applications and 5th Intl. Symposium on Magnetic Anisotropy and Coercivity in Rare Earth-Transition Metal Alloys  
Bad Soden, West Germany  
August 31-September 3, 1987  
\*This issue

\*New Listing or Change

### In the News

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in October 1985 and is to last for two years. Professor R. Pauthenet of C.N.R.S. Grenoble is the chief coordinator with J. Laforest, also of C.N.R.S., in charge of the database. The research will be directed by four laboratories, two in the area of materials and one each in the fields of magnet production and applications. Dr. D. Givord of C.N.R.S. and Professor J. M. D. Coey of Trinity College in Dublin will direct work on materials. Dr. I. R. Harris of the Univer-

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**In the News**

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sity of Birmingham will supervise work on the magnets while Dr. R. Hanitsch of the T.U. Berlin will coordinate the development of applications for the magnets. It is thought that 11 laboratories will be responsible to Dr. Givord, 15 to Dr. Coey, 11 to Dr. Harris, and 16 to Dr. Hanitsch. It will be well into 1986 before the sub-contracts are finalized and everything is in progress.

**New Y<sub>2</sub>O<sub>3</sub> Venture**

Denison Mines, Molycorp, Shin-Etsu Chemicals, and Mitsui have announced that they have agreed on a joint venture to produce yttrium oxide at a new plant to be constructed at Elliot Lake, Ontario, Canada. The capital cost of the venture is estimated at 10 million Canadian dollars (2 billion yen). The plant is to have a capacity of 150 tons per year, roughly 35 percent of the Western World's present needs.

Shin-Etsu Chemical Company, Limited, and Mitsui & Company, Limited, both of Japan, formed SM Yttrium Canada, Limited, as their representative in the venture. Molycorp, Incorporated, will be represented by Union Oil of Canada while Denison Mines, Limited, will handle their own interest in the venture.

The yttrium is to be recovered as a by-product from the existing Denison uranium facilities. The new plant is expected to go on stream in 1986.

**GMELIN HANDBOOK**

The RIC has recently received Volume D 5 of system 39 of the *Gmelin Handbook of Inorganic Chemistry*. This brings to 28 the volumes received and reviewed by the center. Section D is devoted to the description of coordination compounds and the latest describes the carboxylates of Sc, Y, and La to Lu, and the complexes of these elements with esters of carboxylic acids.

Many of these compounds are important for the separation and analysis of the rare earth elements. Since carboxylic acids are frequently used for liquid phase extraction of rare earth cations, numerous references treat the existence and stability of carboxylate species in solution. These results are given in large tables in this volume. A survey on the extraction of individual rare earths by carboxylic acids is in a previous Gmelin volume, D 6 [see *RIC News*, XIX, [3] 3 (1984)]. The water insoluble compounds formed by the dicarboxylic acids and in particular the oxalates are extensively characterized because of their use for gravimetric determinations and in precipitation of the rare earths from various solutions.

The carboxylate anions are versatile ligands capable of binding the metal ion in unidentate, chelating, or bridging modes. This ability has led to an increase in the study of the molecular structure of these compounds. High coordination numbers were found for the rare earths. The complexes of hydroxycarboxylic acids have been given special attention because of the multitude of coordination possibilities. These have been studied for possible chiral ligands.

A formula index at the end of the volume lists all the ligands and their empirical molecular formulas. The ligands include mono-, di-, tri-, and polycarboxylic acids and their hydroxy- and oxo-modifications.

Volume D 5, which contains 385 pages, was published by Gmelin Institute of Inorganic Chemistry of the Max Planck Society for the Advancement of Science, in 1984, and costs DM 1300 (~U.S.\$560.00). The *Gmelin Handbooks* may be ordered from Springer-Verlag, 4005 Marketing Gmelin, Heidelberger Platz 3, D-1000 Berlin 33, West Germany.

**Spedding Award**

(Continued from page 1)

search Establishment where he met Dr. Møller and laid the groundwork for the long-lasting and fruitful collaboration between them. He returned to Denmark in 1966 as a research professor at the Technical University of Denmark. Since 1970 he has been professor of physics at the University of Copenhagen. He was director of the Risø National Laboratory from 1971 to 1976. In 1986, he became director of the Nordic Institute for Theoretical Physics (NORDITA).

Dr. Hans Bjerrum Møller is a native of Denmark and received his master of science degree from the Technical University of Denmark in 1956 and his Ph.D. from the University of Copenhagen in 1968. He began his association with the Risø National Laboratory in 1956 as a scientist. Except for two years at the Brookhaven National Laboratory in the United States and one year at the Euratom Research Center in Italy, he has been there ever since. He became head of Solid State Physics in 1964, head of the Physics Department in 1968, and director of research for Risø in 1982. Dr. Møller was trained as a neutron physicist and is considered one of the best theoreticians in the rare earth field. While much of his work has been in collaboration with Mackintosh, he has worked with other scientists on the magnetic structure and dynamics of mixed-valence systems.

It is acknowledged that Drs. Mackintosh and Møller have had a great influence on the development of rare earth magnetism. They have been at the forefront of the field for over two decades, exploring a host of new ideas and devising experiments to test them. They have discovered and explored many novel and important phenomena. There is no doubt that together they have been responsible for guiding the development of the strong Danish effect in the field. While each of the honorees would merit the award for their own contributions, Dr. Mackintosh, the experimentalist, and Dr. Møller, the theoretician, together form a powerful team. Their joint effort well fits the idea behind the Spedding Award, recognition of research and leadership in the rare earth field that typifies the efforts and dedication of Dr. Frank H. Spedding.

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## \* Contributors \*

The growth of sponsors has continued through the third quarter of our fiscal year. We received support from 22 sponsors raising the total number of benefactors to 68. This is 16 ahead of last year at this time and only 1 less than all of last year when we set a record for the number of sponsorships received. Three new members joined our growing family and 19 others renewed their support. We thank all of you.

The 22 companies giving support this quarter, with the number of years the sponsor has given to the Center in parentheses, are listed below.

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## Rare Earthers HERBERT SCHÄFER

The RIC recently was notified of the sudden and unexpected death of Professor Herbert Schäfer on January 2, 1986. He was active in the study of crystal chemistry of ternary compounds, including some involving rare earths. He worked with F. Steglich on the heavy fermion superconductor  $CeCu_2Si_2$ . His colleagues at the Eduard-Zintl Institute of the Technischen Hochschule in Darmstadt will miss him greatly. We have lost an acknowledged scholar and are saddened by his passing.

## Fellow IEEE

Dr. Karl J. Strnat was recently honored by being elected as a fellow of the Institute of Electrical and Electronics Engineering Society. He was honored for "... contributions to the science and technology of rare-earth permanent magnets and to engineering education in applied magnetics." Karl is a professor at Dayton University, Dayton, Ohio, U.S.A., and besides the many papers he has authored or coauthored, he has been active in all nine workshops and five symposiums dealing with rare-earth permanent magnets and their applications.

## REMACOR

Dr. James W. Robinson has joined Reactive Metals & Alloys Corporation (REMACOR) as vice president of technology. REMACOR is located in West Pittsburg, Pennsylvania, and is a producer of specialty metals and  
(Continued in next column)

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\*\* THANKS \*\*

This year, four companies qualify for addition to our select list of sponsors that have been with us for 10 years or more. They are CERAC, Incorporated; Inland Motor Division of the Kollmorgen Corporation; Reactive Metals & Alloys Corporation (REMACOR); and Transelco Division of the Ferro Corporation. They join the 25 other honorees bringing to 29 the sponsors who have been in our family of benefactors for at least 10 years. We are appreciative of all our sponsors, but wish to express a special thanks to these long time friends.

(Continued from previous column)  
alloys for the iron and steel industry. Dr. Robinson received his B.S. degree from Cornell and his M.S. and Ph.D. degrees from Michigan. He had worked as manager of international technical services for Pfizer, Incorporated in Wallingford, Connecticut.