The Rare Earths in Modern Science and Technology

Volume 3

The Rare Earths in Modern Science and Technology

Volume 3

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FOREWORD

The Fifteenth Rare Earth Research Conference was held June 15-18, 1981 on the Rolla campus of the University of Missouri. The conference was hosted by the Graduate Center for Materials Research, the College of Arts and Science, and the School of Mines and Metallurgy.

It was expected that the conference would provide a forum for critical examination and review of the current and important trends in rare earth science and technology. To this end, over 170 papers were presented in both oral and poster sessions by researchers representing some nineteen countries. The program committee was particularly gratified to see the diversity of effort being devoted to rare earth research by different disciplines all over the world. The collection of refereed papers in this volume attests to the fact that the objectives of the program committee were indeed realized.

A high point of the meeting was the presentation of the Frank H. Spedding Award to a most distinguished colleague, Professor Georg Busch, Eidgenossische Technische Hochschule, Zurich. Professor W. Edward Wallace, University of Pittsburgh, recipient of the first Frank H. Spedding Award made the presentation to Professor Busch who then gave the Plenary Address.

Oral sessions began with keynote addresses delivered by: B.D. Sykes, University of Alberta; J.E. Greedan, McMaster University; M. Tecotzky, U.S.R. Chemicals; J.R. Jackman, Reactive Metals and Alloys; J. Owens, Harshaw Chemical; W.T. Carnall, Argonne National Laboratory; M.B. Maples, University of California-San Diego; R. Lemaire, Neel Laboratory, Grenoble, France; W.J. Evans, University of Chicago; E. Kaldis, ETH, Zurich, Switzerland; R.G. Barnes, Iowa State University; and P. Muntz, Universitat Konstanz/FRG.

The success of any scientific meeting depends largely upon the voluntary efforts of many dedicated people. I first wish to

acknowledge with much appreciation the advice and assistance given me upon assuming my duties as president of the board and conference chairman by the past conference chairman and secretary, Professor John Gruber and Faye Kalina.

The success of the program is testimony to the talents of Professor Gregory Choppin and the excellent job done by his program committee and session chairpersons.

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I appreciate the many hours of work contributed by those who served on the following committees:

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We are all deeply indebted to the co-editors of the Conference Proceedings who gave many hours to the organization and refereeing of the papers in bringing you Volume 3 of "The Rare Earths in Modern Science and Technology".

We are also very appreciative of the monetary support provided to the Conference by the following donors:

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I must acknowledge, especially, the invaluable help and counsel of Norma Fleming, Conference Coordinator, and her staff, and of Professor Adrian Daane, Chairman of the Local Committee.

I thank very much our secretaries: Faye Kalina for assisting the co-editors with the manuscripts and proceedings, Janet Thompson and Nina Haas, Materials Research, UMR, for assisting with all phases of the Conference activities; Jane Bunting and Audrey Thompson, Extension Office, UMR, for handling mailings and registration; and Gislaine Meneroud, Neel Laboratory, Grenoble, for assisting with registration.

Lastly, I wish to thank all the conference participants for their kindness and congeniality. I look forward to seeing all of you again at the Sixteenth Rare Earth Research Conference at Florida State University in April 1983.

William J. James
General Conference Chairman
University of Missouri-Rolla
November 1981

PREFACE

A coherent picture of research progress and new developments involving the rare earths can be difficult to develop due to the wide dispersal of relevant papers throughout the physics, chemistry and materials literature. We have once again taken advantage of the international gathering of scientists for a Rare Earth Research Conference to present under one cover a comprehensive update of the rare earths in modern science and technology. Authors presenting papers in Rolla were invited to submit papers or notes for this volume. All submissions were refereed. We have included three types of contributions: longer invited review papers, shorter research reports and one or two page notes. The first two are meant to have this volume as their sole publication outlet while the notes are typically from authors who have submitted, or are planning, a full publication elsewhere.

Among the 120 contributions in this volume the reader will find many papers in two of the areas where rare earths have been utilized most heavily over the last two decades, luminescent and magnetic materials. Professor Busch's Spedding Award Address describes the pioneering work of his group at the ETH, Zurich, on such materials and provides us with historical insight into research on the rare earths when their complex electronic structure, spectra and interactions in solids were just beginning to be understood. The role of rare earths in steelmaking is also reviewed. This volume also has strong components in the physical and structural chemistry of rare earth compounds and in the innovative applications of rare earths in bioinorganic, organometallic and coordination chemistry. We also welcome our first contributions from scientists in the People's Republic of China.

H.B. Silber, J.J. Rhyne and I would especially like to acknowledge the many referees whose efforts contributed so much to the quality of this volume.

Gregory J. McCarthy
Fargo, North Dakota
October, 1981

*Presentation of the Frank H. Spedding Award
for Outstanding Contributions to the Science and Technology
of the Rare Earths to
Professor Georg Busch*

GEORG BUSCH

Our Spedding Award recipient has had a scientific career of almost incredible depth and range. Prof. Busch's early interests lay with the phenomenon of ferroelectricity. In that, he had interests in common with the late Prof. Berndt Matthias, whose origin was also in the Eidgenössische Technische Hochschule Zurich.

Prof. Busch became interested in the 1940's in semiconductor physics and in the early 1950's he began a search for a ferromagnetic semiconductor. In time he realized that his great quest led

inexorably to the rare earths. (My feeling is that when you need a certain material property you can nearly always find it among the rare earth systems.) In his studies of rare earth-containing III-V semiconductors, such as GdN and CeP, and II-VI semiconductors, such as EuS and TmS, he found his ferromagnetic superconductor.

In his work on the rare earth chalcogenides and pnictides he wrote a new chapter in the solid state sciences. Recognizing the importance of chemical control, Prof. Busch established a Solid State Chemistry Group within his Solid State Physics Institute and they produced and studied in great depth single crystals of the rare earth pnictides and chalcogenides which had been characterized in the most exhaustive detail.

His work of the 60's and 70's involved synthesis and studies of the structural, thermodynamic, magnetic and optical properties of this large class of inorganic compounds. Prof. Busch's work involved classical studies such as determination of specific heats and bulk magnetization but also involved more recently introduced techniques such as ESR, XPS and spin-polarized photoemission. The latter is, I believe, a first in Prof. Busch's laboratory. If you wish to know all about his rare earth chalcogenide and rare earth pnictide work, then you have the job of reading about 110 papers which he has published on these materials.

Recently his attention has turned to intermetallic hydrides -- hydrogen storage systems -- structures of complex hydrides and surface features. In the early 1960's our group in Pittsburgh began work on rare earth nitrides. We soon encountered the stunningly brilliant work of Busch and Vogt on rare earth nitrides. And we decided upon other things to do. In our work on hydrides we recognize Busch's group at Zurich as a force to be reckoned with. Or to put it in less pejorative language, the Zurich group under Busch is a world center of excellence in hydride research. And from this excellence I am convinced all the world will profit.

It is a very great pleasure for me to present Prof. G. Busch, the 1982 Spedding Award recipient.

W. E. Wallace
University of Pittsburgh
June, 1981

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