Permanent Magnet Materials And Their Application

Magnetic Materials and their Applications discusses the principles and concepts behind magnetic materials and explains their applications in the fields of physics and engineering. The book covers topics such as the principal concepts and definitions related to magnetism; types of magnetic materials and their electrical and mechanical properties; and the different factors influencing magnetic behavior. The book also covers topics such as permanent-magnet materials; magnetic materials in heavy-current engineering; and the different uses of magnetic materials. The text is recommended for physicists and electrical engineers who would like to know more about magnetic materials and their applications in the field of electronics.

Recently a new family of hard magnetic materials based on Nd-Fe-B was developed. With these compounds permanent magnets with energy products up to 40 MGOe were produced. The greater abundance of Nd combined with the low price for Fe are a hope for producing high qualitative, low cost magnets in the future. Therefore large scale applications are proposed for Nd-Fe-B magnetis. The aim of the scientific part of the present report will be the investigation of the low temperature physical properties of this new family of compounds.

One of the first books to approach magnetism from a metal physics perspective, Permanent Magnetism presents research ideas that are being translated into commercial reality for ferrite and Nd-Fe-B magnets, and follows the discovery of interstitial, intermetallic materials. Written by well-known authors, the book contains a comprehensive yet concise treatment of the fundamental theory underlying permanent magnetism and illustrates applications with modern, permanent magnetic materials, including ceramics and intermetallic compounds. Each chapter contains worked examples to reinforce applications and the appendices include detailed mathematics and tabular data on material properties.

Permanent magnet materials capable of operating at high temperatures (equal or greater than 400 deg C) are required for advanced aerospace power systems. Prior to the UDRI AMPS team's successful program, the best available high temperature permanent magnets could not operate above 300 deg C. The problem for higher temperature operation has been that the strength of conventional magnets, as characterized by their intrinsic coercivity (MHc) drops sharply upon heating. The MHc of the best 2:17 rare earth-transition metal permanent magnets previously available drops from 20 to 30 kOe at room temperature to only 1 to 3 kOe at 500 deg C. This also results in nonlinear 2nd-quadrant induction demagnetization curves (B curves) at temperatures above 200 to 300 deg C. A linear B curve is critical in all dynamic applications such as in generators and motors. The UDRI AMPS team also proposed a new theory of coercivity mechanisms in permanent magnet materials based on this breakthrough result. This new theory explains the variations in the temperature dependencies of coercivity and provides important guidance to the R&D of new magnetic materials. In addition, EEC has successfully commercialized the new high temperature permanent magnets. These advances represent a major breakthrough in high temperature permanent magnet materials.

An essential textbook for graduate courses on magnetism and an important source of practical reference data.

Permanent magnets play an increasingly important role in modern society because they are vital components of numerous domestic and industrial devices. The last few decades have witnessed a quite extraordinary development in the use of hard magnetic materials, especially after the advent of rare earth permanent magnets. The rare earth permanent magnets are unequalled because they combine a high magnetization with an extraordinary magnetic hardness which allows the use of such magnets having the extreme shapes and small dimensions as required in modern devices.

The present study complements the study on patents, patent applications and other literature on rare earth metals based permanent magnets by Frits Andriessen and Marten Terpstra, published by Elsevier Applied Science in 1989, and complements in part the book on Nd-Fe permanent magnets edited by LV. Mitchell, which was the result of a workshop organized by the Commission of the European Communities and held in Brussels on 25 October 1984. The difference between the content of the first book and that of the present study is that the first is more specifically directed to various kinds and compositions of alloys used in newly developed magnets, while the present book emphasises the improvements obtained when using particular alloys. The study edited by Mitchell deals more specifically with the economic, physical and chemical aspects of rare earth metals based magnet alloys, their properties compared with the more common and classical magnets such as ferro-cobalt alloy magnets, and their applications to various fields of technology. From the present study it has become apparent that there exist only a few patents and patent applications covering a specific use of particular magnets having specific properties to a circuit, arrangement, device or electric motor. This appears to be due to the fact that every manufacturer of such circuits or arrangements applying magnets naturally wants to employ the most effective magnets.

Comprehensive design text for permanent magnets and their application.

This concise book presents the basic concepts of magnetism and magnetic properties pertinent to permanent magnetic materials. Emphasis is placed on hexaferrite materials for permanent magnet applications, with M-type ferrites as the focal point. The relatively high metallicity of magnetic materials for practical applications imposes limitations for their efficient use. Accordingly, magnetic oxides with ferromagnetic properties emerged as the most widely used magnetic materials for practical applications, owing to their characteristic high resistivity and low eddy current losses, chemical stability, simplicity of production in mass quantities, and other favorable characteristics. An important class of these oxides is the class of hexagonal ferrites developed in the early 1950’s, which dominated the world market of permanent magnet applications since the end of the 1980’s. Among these ferrites, the magnetoplumbite (M-type) hexaferrite, is produced nowadays in large quantities at very competitive low prices, thus providing the permanent magnet market with probably the most cost-effective magnetic material.

Commences with a review of the fundamental concepts of magnetostatics and the analysis of solutions to problems in simple geometrics, followed by the design of magnetic structures. The third section analyzes two major aspects of the magnetic structures and demagnetization properties of actual magnetic material. Offers a number of practical uses for permanent magnets, particularly to Magnetic Resonance Imaging and also includes industrial machinery, high energy accelerators and free electron lasers.

Magnets have been objects of fascination for millenia. The new rare-earth iron magnets store 1,000 times the energy of their predecessors, with applications ranging from personal stereos to computer drives to medical scanners. This book offers the first integrated account of the whole field, addressed to physicists, metallurgists and electrical engineers.

This book deals with the basic phenomena that govern the magnetic properties of matter, with magnetic materials and with the applications of magnetism in science, technology and medicine. It is the collective work of twenty-one scientists, most of them from Laboratoire Louis Neel du CNRS in Grenoble, France. The original version, in French, was edited by Etienne du Trémolet de Lacheisserie, and published in 1999. The present version involves, beyond the translation, many corrections and complements.

The primary focus of Modern Permanent Magnets is to provide an update on the status and recent technical developments which have occurred in the various families of permanent magnets that are produced today. The book provides readers with an overview of the key advances of permanent magnet materials that have occurred in the last twenty years. First, the book provides readers with important context including the history of permanent magnets and the fundamental properties of permanent magnets. These chapters are followed by an overview of the important families of permanent magnets that are produced today. Coatings used to protect permanent magnets and the various tests used to confirm that these magnets meet all specifications are discussed.

Finally, the major applications for each family of permanent magnets and the size of the market for these applications are provided. The book includes an Appendix providing a Glossary of Magnetic Terms to assist the readers in better understanding the technical terms used in the other chapters. Modern Permanent Magnets is suitable for materials scientists and engineers working in academia and in industry R&D. Provides an in-depth overview of all of the important families of permanent magnets that are produced today by leading technical figures in each area Includes background information on the fundamental properties of permanent magnets, major applications of each family of permanent magnets and advances in coating and coating technology Reviews the fundamentals of permanent magnet design

Magnetism, Magnetic materials, Magnets, Permanent magnets, Magnetic measurement, Magnetic field measurement, Magnetic fields, Magnetic properties of materials

Permanent magnets are all around us in our daily lives. Very few people comprehend their existence. Can you imagine being without color televisions, radios, stereos, telephones, computers, microwaves, & all those modern appliance in your kitchen? People have always been fascinated by magnets, but the average person does not know nor understand the importance that magnets play in their daily lives. This "Short Course" gives in layman's terms a complete history, today's applications, description of permanent magnets, specifications, design factors, glossary, sources for permanent magnets & magnetic instrumentation, & a special section on Space Powered Generators using permanent magnets. In most libraries today, you will find little published on permanent magnets in the last ten years. Cassady, with twenty-three years experience in magnetics, expresses in an easy-to-read format the importance of permanent magnets in today's society & has put together an excellent reference resource of information on permanent magnets that will make you "magnet" literate. Published in 8 1/2" x 11" trim with 192 pages, perfect bound, & laminated cover. The best on the market today! Send check/money order to SLJ Publishing Company, Box 152, Hanna, IN 46340-0152, $59.99 plus $3.50 postage/handling, or use Baker & Taylor noting ISBN.

In this book, the fundamentals of magnetism are treated, starting at an introductory level. The origin of magnetic moments, the response to an applied magnetic field, and the various interactions giving rise to different types of magnetic ordering in solids are presented and many examples are given. Crystalline-electric-field effects are treated at a level that is sufficient to provide the basic knowledge necessary in understanding the properties of materials in which these effects play a role. Itinerant-electron magnetism is presented on a similar basis. Particular attention has been given to magnetocrystalline magnetic anisotropy and the magnetocaloric effect. Also, the usual techniques for magnetic measurements are presented. About half of the book is devoted to magnetic materials and the properties that make them suitable for numerous applications. The state of the art is presented of permanent magnets, high-density recording materials, soft-magnetic materials, Invar alloys and magnetostrictive materials. Many references are given.

A long overdue update, this edition of Introduction to Magnetism and Magnetic Materials is a complete revision of its predecessor. While it provides relatively minor updates to the first two sections, the third section contains vast updates to reflect the enormous progress made in applications in the past 15 years, particularly in magnetic recordin

Many advances in magnetic materials have resulted from the ability to structure materials on an appropriate magnetic length strip. This is typically the exchange length or the domain wall width of a hard phase, but in either case the characteristic length scale is a few nanometers. As the dimensions of the grains in a magnetic nanostructure approach this limit, the magnetic properties become significantly different from those in bulk. More specifically, nanostructured materials significantly extend the range of available magnetic properties. A variety of materials processing issues centers on the need to control nucleation and crystal growth on a very small length scale. Additional issues focus on the nature of the grain boundaries and the exchange coupling across them. This book provides a comprehensive overview of developments in the field. Topics include: permanent magnet processing; intrinsic properties of permanent magnetic materials; nanoscale hard magnetism; permanent magnet applications; microstructure and micromagnetics; thin-film permanent magnets; fine-particle magnets; nanocrystalline antiferro- and ferrimagnets; ultrasoft nanocrystalline and amorphous materials and nanocrystalline magnetic thin films.

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Volume 17 of the Handbook on the Properties of Magnetic Materials, as the preceding volumes, has a dual purpose. As a textbook it is intended to be of assistance to those who wish to be introduced to a given topic in the field of magnetism without the need to read the vast amount of literature published. As a work of reference it is intended for scientists active in magnetism research. To this dual purpose, Volume 17 of the Handbook is composed of topical review articles written by leading authorities. In each of these articles an extensive description is given in graphical as well as in tabular form, much emphasis being placed on the discussion of the experimental material in the framework of physics, chemistry and material science. It provides the readership with novel trends and achievements in magnetism. *composed of topical review articles written by leading authorities *intended to be of assistance to those who wish to be introduced to a given topic in the field of magnetism *as a work of reference it is intended for scientists active in magnetism research *provide the readership with novel trends and achievements in magnetism

In this dissertation, basic and applied research programs are engaged that range from the fundamental magnetism and magnetic properties of ferro- and ferrimagnetic materials to the design and fabrication of rare earth (RE) free permanent and soft magnetic materials for an interior permanent magnet synchronous motor (IPMSM) (i.e., motor for electric vehicles and plug-in electric vehicles) and heat assisted magnetic recording media (HAMR) with 4 Tb/in2 information storage applications. The applied research program emphasizes the design and synthesis of new RE-free permanent magnetic materials and magnetic exchange coupled core(hard)-shell(soft) particles to achieve a high maximum energy product [(BH)max], and the design of an advanced IPMSM based on RE free permanent magnets. The electronic structures of hard magnetic materials such as Mn-Al, Mn-Bi, Mn-Bi-X, Fe-Pt, Fe-Pt-X, SrFe12O19, and SrFe12O19-X (X = transition elements) and soft magnetic materials such as nanocrystalline and Mn-B were calculated based on the density functional theory (DFT), and their exchange coupled magnetic properties with soft magnets were designed according to the size and shape of the particles. The calculated magnetic and electronic properties were used to obtain the temperature dependence of saturation magnetization Ms(T) and anisotropy constant K(T) within the mean field theory. Thereby, the temperature dependence of the maximum energy product [(BH)max(T)] is calculated using the calculated Ms(T) and K(T). The experimental approaches were based on chemical and ceramic processes to synthesize hard and soft magnetic materials. Prior to synthesis, material design parameters were optimized by first-principles calculations and micromagnetic simulations. Lastly, performance of RE-free MnAl, MnBi, SrFe12O19, and Alnico IPMSMs, designed with the finite element method (FEM), at 23 and 200 oC were evaluated and compared to a RE Nd Fe B IPMSM. The performance parameters include torque, efficiency, and power. It was found that the performance of the MnBi and Alnico IPMSM is comparable with the Nd-Fe-B IPMSM.

"A comprehensive and self-contained exposition of the theory and methods used in the analysis and design of permanent magnet and eletromechanical devices."--Back cover.

At a practical level, this compendium reviews the basics of soft and hard magnetic materials, discusses the advantages of the different processing routes for the exploitation of the magnetic properties and hence assists in proper, fail-safe and economic application of magnetic materials. Essential guidelines and formulas for the calculation of the magnetic and electrical properties, temperature and long-term stability of permanent magnets, of inductive components and magnetic shielding are compiled. Selected fields of application and case studies illustrate the large diversity of technical applications. Application engineers will appreciate the comprehensive compilation of the properties and detailed characteristic curves of modern soft and hard magnetic materials. Materials scientists will enjoy the presentation of the different processing routes and their impact on the magnetic properties and students will profit from the survey from the basics of magnetism down to the applications in inductive components, magnetic shielding and magnet assemblies.

Introduction to Magnetic Materials, 2nd Edition covers the basics of magnetic quantities, magnetic devices, and materials used in practice. While retaining much of the original, this revision now covers SQUID and alternating gradient magnetometers, magnetic force microscope, Kerr effect, amorphous alloys, rare-earth magnets, SI Units alongside cgs units, and other up-to-date topics. In addition, the authors have added an entirely new chapter on information materials. The text presents materials at the practical rather than theoretical level, allowing for a physical, quantitative, measurement-based understanding of magnetism among readers, be they professional engineers or graduate-level students.

Magnetic Nanostructured Materials: From Lab to Fab presents a complete overview of the translation of nanostructured materials into realistic applications, drawing on the most recent research in the field to discuss the fundamentals, synthesis and characterization of nanomagnetics. A wide spectrum of nanomagnetic applications is included, covering industrial, environmental and biomedical fields, and using chemical, physical and biological methods. Materials such as Fe, Co, CoxC, MnGa, GdSi, ferrite nanoparticles and thin films are highlighted, with their potential applications discussed, such as magnetic refrigeration, energy harvesting, magnetic sensors, hyperthermia, MRI, drug delivery, permanent magnets, and data storage devices. Offering interdisciplinary knowledge on the materials science of nanostructured materials and magnetics, this book will be of interest to researchers in materials science, engineering, physics and chemistry with interest in magnetic nanomaterials, as well as postgraduate students and professionals in industry and government. Provides interdisciplinary knowledge on the materials science of nanostructured materials and magnetics Aids in the understanding of complex fundamentals and synthesis methods for magnetic nanomaterials Includes examples of real applications Shows how laboratory work on magnetic nanoparticles connects to industrial implementation and applications

Rare Earth Permanent Magnets presents the discussion of the metallurgy and properties of rare earth permanent magnet alloys. The monograph initially provides the elementary aspects of magnetism to enable the reader sufficient understanding of permanent magnetism. The book then discusses the rare earth elements and their alloys with cobalt, copper, and iron; the magnetic properties of various intermetallic compounds relevant to permanent magnets; a detailed account of cast permanent magnets of the Co-Cu-Sm and Co-Cu-Ce systems and their modifications; the important methods of making and manufacturing rare earth permanent magnets by powder metallurgy methods; and comparisons between the well-known permanent magnets and the new rare earth materials. This text will be of value to students, materials engineers, and scientists.

The utility or a permanent magnet is in many applications determined by its maximum energy product, (BH) sub max. This is the maximum value of the product of B and H in the 2nd quadrant of the hysteresis loop. The amount of magnetic material to meet a certain need is inversely related to (BH) sub max. If size of a device is controlled by the volume of magnetic material needed, it is clear that on may downsize the device by using a higher energy product material. High energy permanent magnets find utility in many devices - TWT's, klystrons, linear induction accelerators, etc., as well as electric motors and generators. At present there are only 3 permanent magnet materials in widespread use - SmCo5, Nd2Fe14B and SmCo5-Sm2Co17. Each has weakness. The present study sought to find new and better materials. The findings in this work are described in detail in 33 journal publications. About a third of the effort has been devoted to effecting improvements in existing materials which occur in the SmCo5 or Nd2Fe14B structures. Materials forming in the ThMn12 and LaCo13 structures were also studied. About half of the effort was devoted to developing a preparation scheme to form Fe 6N2, which is reported to have a theoretical energy product of - 200 MGOe. Fe16N2 has been formed but in the presence of large amounts of - Fe and - Fe-N alloy. The enlarged B value reported for Fe16N2 has been confirmed in the present study. (jg).

Rapidly Solidified Neodymium-Iron-Boron Permanent Magnets details the basic properties of melt spun NdFeB materials and the entire manufacturing process for rapidly solidified NdFeB permanent magnets. It covers the manufacturing process from the commercial production of the melt spun or rapidly solidified powder, to the production and properties of both isotropic bonded Nd and hot deformed anisotropic NdFeB magnets. In addition, the book discusses the development and history of bonded rare earth transition metal magnets and the discovery of the NdFeB compound, also covering melt spun NdFeB alloys and detailing the magnetization process and spring exchange theory. The book goes over the production of melt spinning development, the operation of a melt spinner, the processing of melt spun powder, commercial grades of NdFeB magnetic powder and gas atomized NdFeB magnetic powders. Lastly, the book touches on the major application and design advantages of bonded Nd Magnets. Features a unique perspective as the author is not only the inventor of NdFeB magnetic powder, but also played a key role in developing many of the technologies covered Provides a comprehensive look at the history, fundamental properties, production processes, design and applications of bonded NdFeB magnets Includes discussion of the rare earth supply challenge, politics, and systems as it impacts bonded NdFeB magnets