

Nanocrystalline core materials for modern power electronic designs

Multi purpose soft magnetic material improves the performance of inductive components

Dr. Martin Ferch, MAGNETEC GmbH, Langenselbold, Germany

In the recent years, so called nanocrystalline soft magnetic materials enjoyed more and more acceptance in modern power electronic designs. Besides the undisputed excellent performance this is a result of the improved price level in combination with the availability from several sources worldwide.

Characterization and Properties

The nanocrystalline soft magnetic alloy $\text{Fe}_{73,5}\text{Cu}_1\text{Nb}_3\text{Si}_{15,5}\text{B}_7$ is available on the market since several years now under the brand names of FINEMET, VITROPERM or NANOPERM. Initially, with a quite simple but revolutionary production technology a very thin is ribbon is produced from low cost raw materials like silicon and iron. The result is a new generation of material with extraordinary soft magnetic properties. For the first time ever, almost the high flux swing of silicon steel is combined with the even improved high frequency performance of ferrites, namely low losses and high permeability. Furthermore, the new alloy provides by far a better value for the money compared to epoch making Co-amorphous alloys with similar properties, which were introduced into the market in the late 80s. Due to the high price and environmental considerations, Co-amorphous alloys are actually chosen only for special applications.

Material	alloy composition	losses (20kHz, 200mT) [W/kg]	saturation B_{sat} [mT]	magneto- striction λ_s [10^{-6}]	permeability (50Hz) $\mu_r = \mu_{\text{max}}$	max. working temp. [°C]
grain oriented Silicon steel	$\text{Fe}_{97}\text{Si}_3$	> 1.000	2.000	9	2.000-35.000	appx.120
standard crystalline permalloy I	$\text{Ni}_{80}\text{Fe}_{20}$	> 150	1.550	25	12.000 – 80.000	130
standard crystalline permalloy II	$\text{Ni}_{84}\text{Fe}_{16}$	> 100	1.500	25	60.000-125.000	130
advanced Silicon steel	$\text{Fe}_{92,5}\text{Si}_{7,5}$	40	1.300	0,1	16.000	130
Fe- amorphous alloy	$\text{Fe}_{75}(\text{Si,B})_{25}$	18	1.560	27	6.500 – 8.000	150
high performance ferrite	MnZn	17	500	21	1.500 – 15.000	100/120
advanced crystalline permalloy	$\text{Ni}_{80}\text{Fe}_{20}$	> 15	800	1	150.000-300.000	130
Co-amorphous alloys a	$\text{Co}_{73}(\text{Si,B})_{27}$	5,0	550	< 0,2	100.000-150.000	90/120
Co-amorphous alloys b	$\text{Co}_{77}(\text{Si,B})_{23}$	5,5	820	< 0,2	2.000 – 4.500	120
Co-amorphous alloys c	$\text{Co}_{90}(\text{Si,B})_{10}$	6,5	1.000	< 0,2	1.000 – 2.500	120
nanocrystalline alloys I	FeCuNbSiB	4,0	1.230	0,1	20.000-200.000	120/180
nanocrystalline alloys II	FeCuNbSiB	4,5	1.350	2,3	20.000-200.000	120/180
nanocrystalline alloys III	FeCuNbSiB	8,0	1.450	5,5	~ 100.000	120/180

Nanocrystalline Core Materials In Modern Power Electronic

Brendan G. Carr



Nanocrystalline Core Materials In Modern Power Electronic:

Inductors and Transformers for Power Electronics Vencislav Cekov Valchev,Alex Van den Bossche,2018-10-03

Although they are some of the main components in the design of power electronic converters the design of inductors and transformers is often still a trial and error process due to a long working in time for these components Inductors and Transformers for Power Electronics takes the guesswork out of the design and testing of these systems and provides a broad overview of all aspects of design Inductors and Transformers for Power Electronics uses classical methods and numerical tools such as the finite element method to provide an overview of the basics and technological aspects of design The authors present a fast approximation method useful in the early design as well as a more detailed analysis They address design aspects such as the magnetic core and winding eddy currents insulation thermal design parasitic effects and measurements The text contains suggestions for improving designs in specific cases models of thermal behavior with various levels of complexity and several loss and thermal measurement techniques This book offers in a single reference a concise representation of the large body of literature on the subject and supplies tools that designers desperately need to improve the accuracy and performance of their designs by eliminating trial and error

Energy Efficiency of Modern Power and Energy Systems Shady H E Abdel Aleem,Murat Erhan Balci,Muhyaddin Jamal Hosin Rawa,2024-08-15 Energy Efficiency and Management of Power and Energy Systems introduces students and researchers to a broad range of power system management challenges technologies and solutions This book begins with an analysis of system technology s current state the most pressing problems and the background to challenges in integrating renewable energy sources Technologies including smart grids green building and worker requirements are covered Subsequent chapters break down potential management solutions including specific problem solving for solar wind and hybrid systems Finally specific case studies from a global geographical range zero in on critical questions facing the present industry Providing meticulously researched literature reviews for guiding deeper reading Energy Efficiency and Management of Power and Energy Systems leads readers from contextual understanding to specific case studies and solutions for sustainable power systems Addresses the challenges and solutions related to integrating renewable energy sources into the power grid focusing on maintaining power quality and enhancing energy efficiency Provides a comprehensive reference with extensive guidance on deeper reading Develops understanding and solution design using case studies from a global range of geographies with differing power needs and resources Guides readers through evaluation and analysis of the capabilities and limitations of a range of modern technologies

Magnetic Components for Power Electronics Alex Goldman,2012-12-06 Magnetic Components for Power Electronics concerns the important considerations necessary in the choice of the optimum magnetic component for power electronic applications These include the topology of the converter circuit the core material shape size and others such as cost and potential component suppliers These are all important for the design engineer due to the emergence of new

materials changes in supplier management and the examples of several component choices Suppliers using this volume will also understand the needs of designers Highlights include Emphasis on recently introduced new ferrite materials such as those operating at megahertz frequencies and under higher DC drive conditions Discussion of amorphous and nanocrystalline metal materials New technologies such as resonance converters power factors correction PFC and soft switching Catalog information from over 40 magnetic component suppliers Examples of methods of component choice for ferrites amorphous nanocrystalline materials Information on suppliers management changes such as those occurring at Siemens Philips Thomson and Allied Signal Attention to the increasingly important concerns about EMI This book should be especially helpful for power electronic circuit designers technical executives and material science engineers involved with power electronic components

Power Electronics Handbook Muhammad H. Rashid, 2017-09-09 *Power Electronics Handbook* Fourth Edition brings together over 100 years of combined experience in the specialist areas of power engineering to offer a fully revised and updated expert guide to total power solutions Designed to provide the best technical and most commercially viable solutions available this handbook undertakes any or all aspects of a project requiring specialist design installation commissioning and maintenance services Comprising a complete revision throughout and enhanced chapters on semiconductor diodes and transistors and thyristors this volume includes renewable resource content useful for the new generation of engineering professionals This market leading reference has new chapters covering electric traction theory and motors and wide band gap WBG materials and devices With this book in hand engineers will be able to execute design analysis and evaluation of assigned projects using sound engineering principles and adhering to the business policies and product program requirements Includes a list of leading international academic and professional contributors Offers practical concepts and developments for laboratory test plans Includes new technical chapters on electric vehicle charging and traction theory and motors Includes renewable resource content useful for the new generation of engineering professionals

Optimizing Automation in Engineering With Energy Systems and Communication Networks
Balyan, Vipin, Varshney, Tarun, Gupta, Sandeep, Gupta, Gunjan, 2025-07-23 Optimizing automation in engineering relies on the integration of advanced energy systems and communication networks As industries move toward smarter more efficient operations the collaboration between automation technologies sustainable energy solutions and real time data exchange is essential Effective communication networks enable coordination in automated systems while intelligent energy management ensures reliability and sustainability This convergence enhances system performance and reduces operational costs while supporting the demand for environmentally responsible engineering solutions Exploring this integration may offer valuable insights into the future of automated engineering and its role in smarter infrastructure Optimizing Automation in Engineering With Energy Systems and Communication Networks explores how the integration of automation energy systems and communication networks can improve efficiency reliability and sustainability in engineering applications It examines the

ways in which real time data exchange and intelligent energy management contribute to optimizing automated processes and infrastructure This book covers topics such as data science fuzzy logic and sustainability and is a useful resource for engineers business owners academicians researchers and data scientists

TMS 2020 149th Annual Meeting & Exhibition Supplemental Proceedings The Minerals, Metals & Materials Society, 2020-02-13 This collection presents papers from the 149th Annual Meeting Exhibition of The Minerals Metals Materials Society

High Pressure Technology of Nanomaterials Witold Łojkowski, John R. Blizzard, 2006 The aim of the celebrated High Pressure School HPS is to provide a platform where both young and experienced researchers can meet and exchange their experiences in high pressure research techniques

Continuous Nanophase and Nanostructured Materials: Volume 788 Sridhar Komarneni, John C. Parker, John Calvin Parker, James J. Watkins, 2003 This book focuses on recent advances in nanostructured and nanophase materials and their applications Nanostructured materials consist of domains of less than 100nm and include atom clusters and cluster assemblies one and two dimensionally modulated layers and three dimensional structures The term nanophase refers to structures comprised of domains or particles of a single material that are typically less than 100nm whereas nanocomposite refers to a composite of more than one nanophase Nanoscale materials can be engineered as homogeneous or porous ceramics metals metal oxides semiconductors organic polymers or as composite materials containing these components This book brings together scientists from many disciplines to share and discuss advances in the field Topics include nanophase materials nanocomposite materials nanoporous materials nanostructured materials applications and properties of nanostructured materials carbon nanotubes nanostructured thin films and coatings and theoretical and modeling studies of nanostructured materials

Modern Nonlinear Optics Myron Wyn Evans, 2001

Electron Technology, 1995

Handbook of Magnetism and Advanced Magnetic Materials: Fundamentals and theory Helmut Kronmüller, Stuart S. P. Parkin, 2007

Electrical & Electronics Abstracts, 1997

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Table of Contents Nanocrystalline Core Materials In Modern Power Electronic

1. Understanding the eBook Nanocrystalline Core Materials In Modern Power Electronic
 - The Rise of Digital Reading Nanocrystalline Core Materials In Modern Power Electronic
 - Advantages of eBooks Over Traditional Books
2. Identifying Nanocrystalline Core Materials In Modern Power Electronic
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Nanocrystalline Core Materials In Modern Power Electronic
 - User-Friendly Interface
4. Exploring eBook Recommendations from Nanocrystalline Core Materials In Modern Power Electronic
 - Personalized Recommendations
 - Nanocrystalline Core Materials In Modern Power Electronic User Reviews and Ratings

- Nanocrystalline Core Materials In Modern Power Electronic and Bestseller Lists
- 5. Accessing Nanocrystalline Core Materials In Modern Power Electronic Free and Paid eBooks
 - Nanocrystalline Core Materials In Modern Power Electronic Public Domain eBooks
 - Nanocrystalline Core Materials In Modern Power Electronic eBook Subscription Services
 - Nanocrystalline Core Materials In Modern Power Electronic Budget-Friendly Options
- 6. Navigating Nanocrystalline Core Materials In Modern Power Electronic eBook Formats
 - ePub, PDF, MOBI, and More
 - Nanocrystalline Core Materials In Modern Power Electronic Compatibility with Devices
 - Nanocrystalline Core Materials In Modern Power Electronic Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Nanocrystalline Core Materials In Modern Power Electronic
 - Highlighting and Note-Taking Nanocrystalline Core Materials In Modern Power Electronic
 - Interactive Elements Nanocrystalline Core Materials In Modern Power Electronic
- 8. Staying Engaged with Nanocrystalline Core Materials In Modern Power Electronic
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Nanocrystalline Core Materials In Modern Power Electronic
- 9. Balancing eBooks and Physical Books Nanocrystalline Core Materials In Modern Power Electronic
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Nanocrystalline Core Materials In Modern Power Electronic
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Nanocrystalline Core Materials In Modern Power Electronic
 - Setting Reading Goals Nanocrystalline Core Materials In Modern Power Electronic
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Nanocrystalline Core Materials In Modern Power Electronic
 - Fact-Checking eBook Content of Nanocrystalline Core Materials In Modern Power Electronic
 - Distinguishing Credible Sources

13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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