

# Development Trends of Soft Magnetic Iron

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Recent developments in electronically controlled systems for automobiles are focused on providing for soft magnetic materials that can provide a large electromagnetic flux with low eddy current losses, which will help the various systems better than developed in combination of high DC electromagnetic properties such as cold crystallization and permeability. This paper describes the recent development trends of soft magnetic steel and the achievement of steel developed steel (DSD/DCI system).

## Introduction

Recently automobiles are being heavily equipped with various systems operated electrically, electronically and/or electromagnetically to various sensors, control and fuel economy. Such systems include integrated controlled automatic transmission, electronic power steering (EPS) and anti-lock braking systems (ABS)<sup>1-3</sup>.

In the early years (1970s, 1980s) when electric and electronic devices started to be used in automobiles, the main purpose was to improve and upgrade the performance of individual systems. Highly complicated vehicles started to mount power windows, air conditioning, high-speed lockage and numerous combination power-differential systems. Hence electronically and/or electromagnetically controlled management are becoming increasingly important.

Among these electronically and/or electromagnetically controlled systems, components that utilize electromagnetic force (permeability loss) come to their minds to generate magnetic fields. Many conventional ones consist of low carbon steel, containing about 0.05% of carbon, to improve the response to control signals and increase energy efficiency.<sup>4-6</sup> With the remarkable advancement of electromagnetic control in recent years, it has become essential to electronically components to have even higher performance and lower power consumption.

This paper describes the trend of soft magnetic materials, such as those for low losses used in electromagnetic components, and introduces the characteristics of the new, low-loss soft magnetic materials in the DSD/DCI (Steel Low Carbon Cold Heading Steel) series developed by New Steel.

## 2. Transition of soft magnetic materials

Fig. 1 depicts the structure of a solenoid device

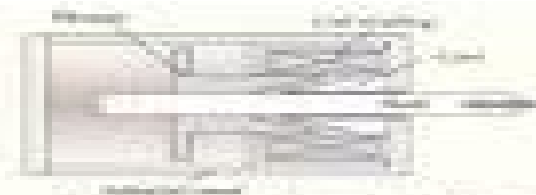


Fig. 1 Example of solenoid structure

by hydraulic control. This is a typical example of the electromagnetic components used in automobiles. Soft magnetic materials are usually used for these cases that have magnetic circuits and for the housings including cores.

Early solenoid devices for automobiles were mainly used for controlling the oil flow by small sections. Thus, the reliability and workability of low cost materials were more important than their magnetic characteristics. As a result, low carbon steels such as SAE1010, SAE1015, SAE1018 and SAE1020 (JIS-C 1008) were used for the housings.

Recent solenoid devices, however, must be able to control hydraulics exactly and stably. In contrast this, the control system is being replaced by linear control in many cases.<sup>7-9</sup> On the linear control, the control current must be proportional to the grating force (electromagnetic force) of the iron cores, which increases with magnetic materials having low coercivity (low hysteresis) at high flux density. The latest iron core materials for linear solenoids are required to have magnetic characteristics better than those of SAE1018 (JIS-C 1018), making it difficult to use carbon steel. Recently used for exact control, to satisfy the required characteristics of magnetic flux density and coercivity (Fig. 2).

In the mid-1980s, New Steel worked to totally change factors that can adversely affect the magnetic characteristics of soft magnetic materials and developed a soft magnetic material, DSD/DCI (Steel low loss iron), which can achieve the best characteristics among 90 grade (90-94% Fe) materials.<sup>10</sup> The company has studied parts having using a large power and parts function from the material is being widely used as a soft magnetic material for coil binding.

In the late 1990s, there was an increasing need for

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**Phillip J. Peterson**



## **Development Trends Of Soft Magnetic Iron:**

**New Trends in Alloy Development, Characterization and Application** Zaki Ahmad, 2015-09-24 The book explores the new developments that have taken place in recent years in the processing and application of aluminium alloys The chapter on self diffusion shows a complete detail of the mechanism of diffusion in aluminium alloys and how it affects the strength The chapter on native oxide films gives useful information on the films developed on commercial magnesium alloys On the analytical side the details of Mossbauer spectroscopy related to aluminium alloys fully described One recent development in aluminium alloys is the controlling of pitting corrosion by the application of superhydrophobic coatings Complete details of the theory and application of hydrophobicity related to aluminium alloys is shown in the two chapters related to hydrophobicity It is hoped that this book will be found useful by researchers and general readers in the areas described in the book

**Wide Bandgap Power Semiconductor Packaging** Katsuaki Suganuma, 2018-05-28 Wide Bandgap Power Semiconductor Packaging Materials Components and Reliability addresses the key challenges that WBG power semiconductors face during integration including heat resistance heat dissipation and thermal stress noise reduction at high frequency and discrete components and challenges in interfacing metallization plating bonding and wiring Experts on the topic present the latest research on materials components and methods of reliability and evaluation for WBG power semiconductors and suggest solutions to pave the way for integration As wide bandgap WBG power semiconductors SiC and GaN are the latest promising electric conversion devices because of their excellent features such as high breakdown voltage high frequency capability and high heat resistance beyond 200 C this book is a timely resource on the topic Examines the key challenges of wide bandgap power semiconductor packaging at various levels including materials components and device performance Provides the latest research on potential solutions with an eye towards the end goal of system integration Discusses key problems such as thermal management noise reduction challenges in interconnects and substrates

**Trends and Opportunities in Materials Research**, 1984 **Amorphous Magnetism and Metallic Magnetic Materials -**

**Digest** A.R. Ferchmin, S. Kobe, 1983-09-01 This unique book provides the reader with the only comprehensive overview of the subject It is an indispensable reference source in that it attempts to compress into one single volume the whole body of basic and applied research on amorphous magnetic metallic materials Supplements to the Journal of Magnetism and Magnetic Materials appear regularly keeping the information contained in this book as up to date as possible The book has been designed for easy use and is a must for researchers in the field

**Magnetic Materials in Japan** Japan Technical Information Japan Technical Information Se, 2013-10-22 Please note this is a Short Discount publication This the third report in Elsevier's Materials Technology in Japan series concentrates on magnetic materials as a topic gaining worldwide attention and each chapter looks not only at current research but also describes the technology as it is being applied and its future potential Magnetic related research is the second largest field of research in Japan after semiconductors with the estimated

number of researchers and engineers engaged in magnetics related activities currently at 20 000 This research report serves as both a review of research undertaken and developments to date and a forecast of where the industry is going Soft Nanoferrites for Biomedical and Environmental Applications Atul Thakur, Preeti Thakur, 2024-10-11 Spinel nanoferrites have emerged as an advanced class of nanostructured materials in the domains of nanoscience and technology over the past decade This book covers the fundamentals of spinel ferrites and their applications in the health sector and the environment It focuses on the key applications of spinel ferrites in the health sector such as hyperthermia cancer diagnosis treatment and antimicrobial activity as well as in environmental issues like water purification wastewater treatment and air pollution remediation Features Covers the classification synthesis properties structures and applications of spinel ferrites Provides exclusive coverage of biomedical and environmental applications Includes discussions on environmental pollution types of pollutants and the removal of those pollutants using spinel nanoferrites Reviews applications in cancer diagnosis and treatment MRI hyperthermia and related fields Recommends building environmentally friendly ferrite materials for a clean environment This book is aimed at graduate students and researchers in materials science nanotechnology environmental science and bioengineering *Rapidly Solidified Alloys* Howard H. Liebermann, 1993-05-20 This volume details the principles underlying rapid solidification processing material structure and properties and their applications This practical resource presents a manifold approach to both amorphous and crystalline rapidly solidified metallic alloys Written by over 30 internationally acclaimed specialists in their respective fields **Proceedings of the 3rd International Conference on Physics of Magnetic Materials, Szczyrk-Biła (Poland), September 9-14, 1986** W. Gorzkowski, Henryk K. Lachowicz, H. Szymczak, 1987 *TMS 2023 152nd Annual Meeting & Exhibition Supplemental Proceedings* The Minerals, Metals & Materials Society, 2023-02-06 This collection presents papers from the 152nd Annual Meeting Exhibition of The Minerals Metals Materials Society 3rd Hungarian Conference on Materials Science, Testing and Informatics József Gyulai, 2003 This 3rd Conference on Materials Science Testing and Informatics provided an invaluable forum for discussions on Functional Materials and Technologies for the New Millennium **Materials Processing Technology, ICAMMP2011** Xianghua Liu, Zheng Yi Jiang, Jing Tao Han, 2011-12-06 Selected peer reviewed papers from the Second International Conference on Advances in Materials and Manufacturing Processes ICAMMP 2011 December 16 18 2011 Guilin China **Corrosion of Electronic and Magnetic Materials** Phillip J. Peterson, 1992 Addresses the changing definitions and approaches to corrosion occasioned by the size reductions and new materials of electronic components in devices that compete on the market to be ever smaller faster and functional in environments hostile to electronics e g the beach The 10 papers are from Characterization and Measurement of Magnetic Materials Fausto Fiorillo, 2004-12-07 Correct and efficient measurements are vital to the understanding of materials properties and applications This is especially so for magnetic materials for which in last twenty years our understanding and use have changed dramatically New or improved

materials have been created and have reached the market The Soft amorphous alloys the Fe based rare earth magnets and the giant magnetorestrictive and magnetoresistive materials have all posed challenges to measurement At the same time new digital measurement techniques have forced a change in laboratory and commercial measuring setups A revision of measuring standards also occurred in the 1990s with the result that there is now a lack of up to date works on the measurement of magnetic materials The basic objective of this work is to provide a comprehensive overview of the properties of the hard and soft magnetic materials relevant to applications and of thoroughly discussing the modern methodologies for employed in the measurement of these properties The balance of these topics results in a complete text on the topic which will be invaluable to researchers students and practitioners in industry It will be of significant interest not only to scientists working in the fields of power engineering and materials science but also to specialists in measurement who be able to easily find all the information they need Comprehensive overview of the properties of the hard and soft magnetic materials Provides applications and discusses thoroughly the modern methodologies for employed in the measurement of these properties Provides the latest up to date works on the measurement of magnetic materials

Functionalized Magnetic Nanosystems for Diagnostic Tools and Devices Kalim Deshmukh, Chaudhery Mustansar Hussain, 2024-01-12 Functionalized Magnetic Nanosystems for Diagnostic Tools and Devices Current and Emerging Research Trends explores the various aspects of functionalization of magnetic nanosystems in great detail providing a thorough review of the associated benefits and challenges The book begins with an overview of each key pillar for the design and application of functionalized magnetic nanosystems from the synthesis processing methods and characterization techniques to biocompatibility and toxicity considerations Later chapters focus on specific nanomaterials and targeted biomedical applications including point of care diagnosis cancer therapy medical imaging biosensing and more Importance is given to the safety considerations environmental legal and ethical implications and commercial aspects of functionalized magnetic nanosystems providing guidance relevant for advancing research into clinical practice Provides an overview of fundamentals in the design and application of magnetic nanosystems from synthesis and processing to functionalization and toxicity assessment Explores research in industry and clinical practice providing insights into ethical environmental legal and commercial aspects Covers a wide range of diagnostic applications for functionalized magnetic nanosystems such as in medical imaging drug detection tissue engineering and more

Physics Of Magnetic Materials - Proceedings Of The 4th International Conference Waldemar Gorzkowski, Henryk Szymczak, Henryk Lachowicz, 1989-04-01

Modern Ferrites, Volume 2 Vincent G. Harris, 2022-11-08 MODERN FERRITES Volume 2 A robust exploration of the basic principles of ferrimagnetic and their applications In Modern Ferrites Volume 2 renowned researcher and educator Vincent G Harris delivers a comprehensive overview of ferrimagnetic phenomena and discussions of select applications of modern ferrite materials in emerging technologies and applications Volume 2 explores fundamental properties of ferrite systems including their structure chemistry and magnetism as well as

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