稀土钴永磁材料及应用论文选集

SELECTED PAPERS OF RARE EARTH-COBALT PERMANENT MAGNETS AND THEIR APPLICATIONS

電子工業出版社

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电子工业部元器件工业管理局编

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内 容 简 介

稀土钴永磁材料是近20年来发展起来的一代新型永磁材料，它具有优异的永磁性能。本书收选了电子工业部所属研究所及工厂近几年来稀土钴永磁材料的研制及应用方面的主要论文31篇。这些论文大多曾在国内外学术刊物上发表过，或曾在国内外学术会议上宣读过，有的还曾获得国家或部级奖励。本书对从事磁性材料研究、生产和应用的科研人员、工程技术人员有一定的参考价值，也可供有关专业的大专院校师生、中等专业学校的教师阅读。

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前　言

稀土钴永磁材料是近二十年来发展起来的一种高性能永磁材料。它具有很高的矫顽力和最大磁能积，是其它永磁材料所不能比拟的。虽然它的价格较贵，但它的性能优异，所以，首先在军事电子设备，空间电子设备以及民用电子设备上得到应用。近几年来，又逐渐推广到电机、机械、仪表和医疗设备等各个方面。据D.Weinmann和F.Gallo统计：全世界稀土钴永磁的销售额在1981年为六千多万美元，预计平均年增长率为15%，到1985年将超过一亿美元。按用途分类，1981年美国稀土钴永磁总销售量中，用在军事电子设备，空间电子设备及民用电子设备中的占55%，欧洲占43%，日本占70%，但日本总销售量的65%是用在民用电子设备中，如收音机、电视机、高保真收录音设备及电子表等。在我国，高性能的RCo_5和R_2Co_{17}永磁材料用于电子设备中的也占很大比例，多数用于超高频电真空器件，音响设备及电机。

近十多年来，我国电子工业部所属的研究所及工厂对稀土钴永磁材料的研究、生产及应用做了大量的工作，在基础研究、材料研制、器件设计、生产技术和推广应用等方面均有相当的成果。

电子工业部西南应用磁学研究所于1969年开始研究稀土钴永磁材料，1975年最大磁能积达到16～18MG·Oe，1977年及1978年先后定型通过了20及24MG·Oe的RCo_5材料，1980年5月部级鉴定通过了30MG·Oe的R_2Co_{17}材料的设计定型。这些材料都达到了国际上同类产品的先进水平。该所的一些材料样品曾送往美国、日本、瑞士的实验室或工厂测试过，得到他们很高的评价。

电子工业部金川无线电器材厂、北京第三无线电器材厂、金山无线电器材厂、金宁无线电器材厂以及国光电子管厂等是我国试制和生产稀土钴永磁材料较早的工厂。北京真空电子器件研究所、北京电子管厂、国光电子管厂都将稀土钴永磁材料用于微波管。成都微

电机厂，上海微电机研究所将稀土钴永磁材料用于各种微电机。稀土钴永磁材料的生产量逐年增加，应用也越来越广泛。已用于薄型扬声器、立体声耳机、行波管、返波管、磁控管、速调管，力矩电机、平面电机、永磁直流电机、大功率电机、磁悬浮轴承、磁力传动器、磁控溅射、激光系统、高能粒子偏转系统等方面。此外，还用稀土钴永磁体进行磁疗、研究磁场对植物的影响等等。

稀土钴做为新型永磁材料虽然已有近二十年的历史，但它的应用还仅仅是开始。今后，加强材料的基础研究，以进一步提高磁能积、改善温度稳定性、探索新材料等，无疑是很重要的；但更重要的是开发新应用，设计新型永磁器件，研究合理的设计方法。当然，进一步降低材料的价格以及改进大规模生产工艺也是十分重要的。

本论文集收选了电子工业部所属研究所及工厂近几年来稀土钴永磁材料的研制及其应用方面的一些主要论文，共31篇。其中关于稀土钴永磁材料研究的论文有10篇，稀土钴永磁在电子技术中应用的论文13篇，稀土钴永磁在电机中应用的论文 6 篇，其它方面的论文 2 篇。

本选集既反映出电子工业部系统稀土钴永磁材料发展的历史梗概和现状，又可通过它了解到我们开发的范围。从技术水平看，有些论文写得比较深入，反映了工作的深度和广度。

我们希望：出版此论文集，能增进我们与国内外同行的相互了解与交流；能对从事稀土钴永磁材料研制及应用研究的人们有一定参考价值；能促进这方面的工作得到不断的发展。

受电子工业部元器件工业管理局委托，负责本文集选编工作的是稀土钴永磁材料及应用论文选集编委会。编委会由下列同志组成：张熙（主编）、潘尊五（副主编）、余星锄、李友浩、丁光未、赵柏甲、孙大库、宋后定、胡仁芳。

张　熙

1983年 2 月

Preface

Rare earth cobalt permanent magnetic material is a high performance material developed during the last twenty years. It has a higher coercive force and maximum magnetic energy product than other permanent magnetic materials. Despite high cost, the outstanding performance of this material makes itself useful to military, space and civilian electronic equipments. During recent years, its application extends to those fields as electrical machinery, mechanical equipments, instrumentation, medical appliance etc. According to D. Weinmann and F. Gallo*, the world's total sale of rare earth cobalt permanent materials amounted to more than 60 million US dollars in 1981 and will be over 100 million US dollars in 1985 with a predicted yearly increase rate of 15%. In 1981, 55% of the total value in the United States goes to military, space and civilian electronic equipments; those for Europe and Japan are 45% and 70% respectively. But 65% of the total value goes to radio set, TV, Hi-Fi recorder and receiver, electronic watch and other civilian equipments in Japan. Most of the high performance RCo_5 and R_2Co_{17} permanent magnetic materials produced in China are for electronic equip-

* Proceedings of the International Workshop on REPM and Their Applications, p.485 (1982).

ments, mostly UHF vacuum electron device, audio equipment and electrical machinery.

A large amount of work were done in various research institutes and factories under the Ministry of Electronic Industry in recent ten or more years. Considerable results have been achieved in basic research, material development, device design, production technology and application.

Southwest Research Institute of Applied Magnetics under the Ministry has been engaged in R&D of the REPM material since 1969. RCo_5 with maximum magnetic energy product of 16—18 MG·Oe was successfully developed in 1975. Those with 20 and 24 MG.Oe were finalized in 1977 and 1978. R_2Co_{17} with 30MG·Oe was finalized in 1980. Their performance can be compared with those of similar advanced international products. Some samples were sent for testing to laboratories and factories in the United States, Japan and Switzerland and were highly appraised.

Jingchuan, Beijing No.3, Jingshan and Jingning Radio and Appliance factories and Guoguang Electron Tube Factory under the Ministry are among the earlier producers. Beijing Research Institute of Vacuum Electron Devices, Beijing Electron Tube Factory and Guoguang Factory are using this material in the magnetic field of microwave tube. Chengdu Micromotor Factory and Shanghai Micromotor Research Institute are using this material in their products. The production has increased and the application has spread to ultra-thin loudspeaker, stereo head-

phone, travelling wave tube, backward wave tube, magnetron, klystron, torque motor, planar motor, permanent magnet DC motor, high power motor, magnetic floating bearing, magnetic driver, magnetically-controlled sputtering, laser system, high energy particle deflection system etc. Magnetic therapy by rare earth cobalt permanent magnet and the effect of magnetic field on plants have also been among the topics of research.

The application of this material is still in its infancy, although its first publicity as a new permanent magnetic material dates back to twenty years ago. Further basic research is of significance for increasing its magnetic energy product, improving its temperature coefficient and finding new materials. But what is more important is to look for new applications, to design new permanent magnetic devices and to devise more sensible design principles. Further reducing the cost and improving large scale production processes are also of great importance.

This book includes 31 major articles selected from various research institutes and factories within the Ministry in the field of development and application of rare earth cobalt permanent magnetic material. Of them, 10 devoted to R&D of the material, 13 to application in electronic technology, 6 to application in electrical machinery and 2 to other fields. This compilation reports the developmental process and state-of-the-art of this material within this Ministry. One appreciates the effort made and the range of development of this material from

this book. From the technical point of view, some of the papers give better perspective, reflecting the depth and the full extent of the work.

It is hoped that this compilation may promote the mutual understanding and technical exchange between us and colleagues in and outside this country. It could be a reference to those engaging in the R&D and application of rare earth cobalt permanent magnetic material and may add to the continuous advancement of this new material.

The editorial committee of this book is entrusted by Bureau of Components and Devices, Ministry of Electronic Industry and includes Zhang Xi (editor-in-chief), Pan Zunwu (associate editor-in-chief), Yu Xingchu, Li Youhao, Ding Guangwei, Zhao Baijia, Sun Daku, Song Houding and Hu Renfang.

Zhang Xi

February,1983

目　　录

在电机中的应用

在磁力机械及其他方面的应用

附录

Contents

MATERIALS AND PROCESSES

ELECTRONIC APPLICATIONS

ELECTRO-MECHANICAL APPLICATIONS

MAGNETO-MECHANICAL AND MISCELLANEOUS APPLICATIONS