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SOUTHWEST INSTITUTE OF APPLIED MAGNETICS

中国电子科技集团公司第九研究所
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CETC 中国电科


2023

# 产品手册

Product Manual

## 稀土永磁材料及器件产品手册

中国电子科技集团公司第九研究所


# 关于我们 ABOUT US

西南应用磁学研究所（中国电子科技集团公司第九研究所）创建于1967年，主要从事磁性功能材料与特种元器件的研制、开发、生产、服务以及应用磁学基础研究，是我国唯一的综合性应用磁学科研机构，在国家磁性功能材料与磁性元器件技术领域专业发展方向上具有支撑地位，承担了起草和编制国家和行业标准的工作，如：GB/T4180-2012《稀土钴永磁材料》，GJB2453A-2021《稀土永磁体总规范》等。九所长期以来坚持以科技创新为引领，形成了以磁性材料、磁性元件、磁性组件为主的完善的产业布局，实现了从材料到元件到组件的全产业链自主可控。

Southwest Institute of Applied Magnetics (The 9th Research Institute of China Electronics Technology Group Corporation) was founded in 1967, which is mainly engaged in the research and development of magnetic functional materials and special components, production, service and applied magnetic basic research. Southwest Institute of Applied Magnetics (SIAM ) is the only comprehensive research institution of application magnetic in China, which has a supporting position in the professional development direction of national magnetic functional materials and magnetic compnents technology field,and undertakes the work of drafting and compiling national and industrial standards,such as GB/T4180-2012 Permanent Magnetic Material of Rare Earth Cobalt, GJB2453A-2021 General Specification of Permanent Magnet, and so on.Adhering to scientific and technological innovation for a long time,the institute has formed a complete industrial layout with magnetic materials,magnetic components and magnetic assembly as the main product ,realizing the independent control of the whole industrial chain from material to devices to components.

随着我所在技术及其它各领域能力的提升，挂靠我所的学术、技术、标准、信息及产品检测单位有：

——信息产业磁性产品质量监督检验中心。

——全国磁性元件与铁氧体材料标准化技术委员会；

——IEC/TC51国内技术归口单位；

——中国电子元件协会磁性材料及器件分会；

——中国电子元件协会磁性材料分会；

——信息产业磁性材料及器件专业情报网。

With the improvement of our technology and other fields, SIAM has had some subsidiary units of academic, technical, standards, information and product Inspection, which are as follows:

-Quality Supervision and Inspection Center of Magnetic Products for Information Industry

-The National Standardization Technical Committee of Magnetic Element and the Ferrite Material

-Authority of IEC/TC51 domestic technology

-Magnetic Materials and Devices Branch of Chinese Electronic Components Association

-Magnetic Materials Branch of Chinese Electronic Components Association

-Specialized Information Network of Magnetic Materials and Devices for Information Industry

• 鸟瞰效果图

# 目录 CONTENTS

## 资质/荣誉/专利 Certification/Honor/Patent

自1998年起，九所建立、运行、实施、保持GJB9001质量体系，陆续建立了GB/T 19001质量体系、GB/T 24001环境管理体系和GB/T 45001职业健康安全管理体系。

Since 1998, SIAM has established, operated, implemented and maintained GJB9001 quality system, and successively established GJB 9001 quality system , GB/T 24001 environmental management systems and GB/T 45001occupation health and safety management systems.




九所在钐钴永磁领域拥有专利20余项，国家级、省部级科技进步奖10余项，国际先进水平20余项。

SIAM has more than 20 patents in the field of samarium cobalt permanent magnet,more than 10 national and provincial science and technology progress awards,and more than 20 international advanced level.








## 检测能力 Detectability

拥有X射线检测仪、振动冲击试验台、高低温试验箱、盐水喷雾试验箱、三坐标测量仪等各类检测仪器设备300台套，具备永磁材料及永磁体、软磁材料及磁芯等4个类别42项磁性基础实验项目检测能力。

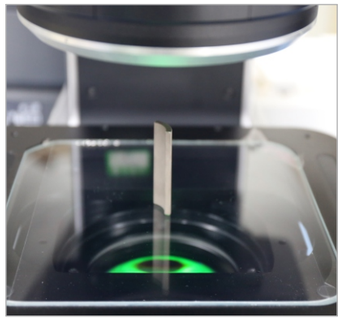
SIAM has 300 sets of various testing instruments and equipment such as X-ray detector,vibration impact test bed,high and low temperature test chamber,saltwater spray test chamber,three coordinate measuring instrument and so on. It has the ability to test 42 basic magnetic experiment items in 4 categories such as soft magnetic materials and magnetic core,permanent magnetic materials and permanent magnets.


X射线检测仪(无损探伤试验)

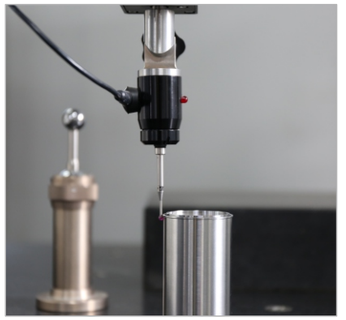

高低温试验箱(高温、低温试验)

振动试验台(振动、冲击试验)

盐水喷雾试验箱



图像尺寸测量仪



三坐标测量仪

## 专业优势 Professional advantages

### 丰富的研发经验 Rich research and development experience

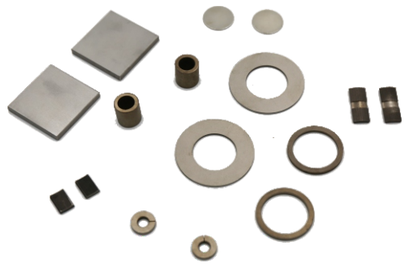
九所在稀土永磁材料及器件领域已有四十余年开发历史，在研发、生产方面积累了丰富的经验和数据，拥有一条军用钐钴永磁材料贯军标生产线。

SIAM has more than 40 years of development history in the field of rare earth permanent , agnet materials and devices,and has accumulated rich experience and data in research and development and production.It has a military samarium cobalt permanent magnet materials through the military standard production line.

### 单项冠军产品 Single champion products

九所钐钴永磁入选工业和信息化部、中国工业经济联合会第七批制造业单项冠军产品。

SIAM samarium cobalt permanent magnets were selected as the seventh batch of single champion products of manufacturing industry by the Ministry of Industry and Information Technology and the china Federation of Industrial Economics.







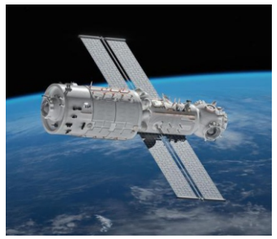
## 稀土永磁材料及器件简介 Brief Introduction

九所稀土永磁材料及器件专业涉及产品主要包括稀土钴永磁材料和钕铁硼永磁材料，以及相关永磁元件、永磁组件。年产稀土钴永磁材料700吨，年产钕铁硼永磁材料2000吨。

The major permanent magnetic products of SIAM include rare earth cobalt permanent magnet materials, neodymium iron boron permanent magnet materials, and related components and assemblies. Annual production of rare earth cobalt permanent magnetic material is about 700 tons, and Annual production of Neodymium iron boron permanent magnetic material is about 2,000 tons.

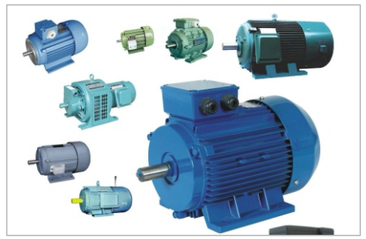
稀土钴永磁材料根据性能特征可分为高性能、高工作温度、高稳定、高温高稳定四种系列。由于其居里温度高、温度稳定性好、高温性能高、耐腐蚀等优点，可广泛应用于武器装备的各种航空航天电机、微波电真空器件、微波无源器件、电机、惯性导航器件及民用的电机、传感器等领域。九所钐钴永磁材料具有内禀矫顽力高，一致性好，磁偏角小等优点。

Rare earth cobalt permanent magnet materials can be divided into four typea according to their performance characteristics:high performance,high operating temperature,high stability and high emperature high stability.Due to its high Curie temperature,good temperature stability ,high temperature performance ,corrosion resistance and other advantages,it can be widely used in various aerospace motors,microwave electro-vacuum devices, microwave passive devices,motors,inertial navigation devices and civil motor, sensor and other fields.The cobalt permanent magnet materials of SIAM has the advantages of High intrinsic coercive force, good consistency, and small magenetic declination.



航空航天领域

风力发电



各类电机

烧结钕铁硼永磁材料具有永磁材料中最高的剩磁和磁能积，可广泛应用于电子、电力机械、医疗器械、玩具、包装等领域。

Sintered neodymium iron boron permanent magnet materials has the highest residual magnetism and magnetic energy product in permanent magnet materials,and can be widely used in electronics, electric machinery, medical instruments,toys,packaging and other fields.

## 生产工艺流程 Production process flow

配 料

mixed ingredients

01

熔 炼

02

sinter

制 粉

Pulverizing

03

成 型

04

forming

烧结、热处理

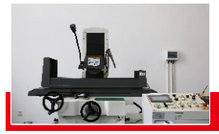
Sintering, heat treatment

05

退磁曲线检测

06

Demagnetization curve detection



加 工

Processing

07

清 洗

08

clean

检 验

Inspection

09

包装发货

10

Packaging and shipping





## 牌号说明 The interpretation of the naming rules of Grade

XG S 239/160 350

温度特性，用阿拉伯数字表示，以×$10^{-6}$/℃为单位的磁矩可逆温度系数绝对值表示。temperature coefficient:×$10^{-6}$/℃

主要磁性能，分子以kJ/$m^3$为单位的最大磁能积$(BH)_{max}$的标称值表示，分母以kA/m为单位的内禀矫顽力$H_{cJ}$最小值的1/10表示，数值采用四舍五入取整数。
Numerator: (BH)max(kJ/$m^3$), Denominator: $H_{cJ}$(kA/m)/10

磁取向特征，用汉语拼音字母表示；缺省表示磁各向异性，F表示辐向磁各向异性，T表示磁各向同性。default :axial orientation, T: Isotropic, F: radiation orientation

制造工艺，用汉语拼音字母表示；S表示烧结，N表示粘结
Process, S: sinter, N: bond

结构类型，1表示$RCo_5$型，缺省时表示$R_2Co_{17}$型
The crystal structure, 1:$RCo_5$, default : $R_2Co_{17}$

XG：稀土钴的首拼字母。XG: Rare Earth Cobalt Permanent Magnet

N 42 SH

M:$H_{cJ}$≥1114 kA/m;H:$H_{cJ}$≥1353 kA/m; SH:$H_{cJ}$≥1592 kA/m;
UH:$H_{cJ}$≥1990 kA/m; EH: $H_{cJ}$≥2387kA/m

(BH)max(MGOe)

N:钕铁硼的首拼字母。N:NdFeB

# 高性能稀土钴永磁材料系列 High Performance Rare Earth Cobalt Permanent Magnet Materials

高性能稀土钴永磁材料具有高磁能积、高剩磁、高内禀矫顽力、较低的温度系数等特点。适用于电真空器件、高可靠电机、传感器等。

High Performance Rare Earth Cobalt Permanent Magnet Materials has the characteristics of high magnetic energy product, high residual induction, high intrinsic coercive force, low temperature coefficient and so on. It is suitable for electric vacuum device, high reliable motors, sensors, etc.

## NIM-500 CHYSTERESIGRAPH TEST REPORT

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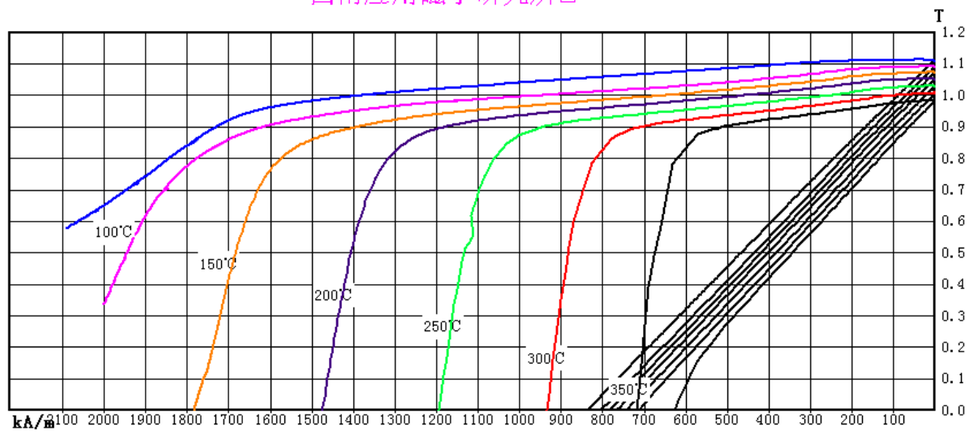


XGS247/199/350材料典型高温退磁曲线
Demagnetization curve of grade XGS247/199/350

| 温度 ℃ | 剩磁Br | | 内禀矫顽力$H_{cJ}$ | | 矫顽力$H_{cB}$ | | 最大磁能积$(BH)_{max}$ | |
|---|---|---|---|---|---|---|---|---|
| | kGs | T | kOe | kA/m | kOe | kA/m | MGOe | kJ/m³ |
| 常温 | 11.2 | 1.12 | 26.3 | 2091 | 10.5 | 839 | 30.2 | 240 |
| 100 | 10.91 | 1.09 | 25.13 | 2000 | 10.12 | 805 | 27.67 | 220 |
| 150 | 10.73 | 1.07 | 22.42 | 1784 | 9.86 | 785 | 26.52 | 211 |
| 200 | 10.53 | 1.05 | 18.54 | 1475 | 9.64 | 767 | 25.43 | 202 |
| 250 | 10.30 | 1.03 | 15.00 | 1194 | 9.35 | 744 | 24.1 | 192 |
| 300 | 10.08 | 1.00 | 11.73 | 934 | 8.98 | 715 | 22.85 | 182 |
| 350 | 9.81 | 0.98 | 9.03 | 719 | 7.89 | 628 | 21.61 | 172 |





| 系列 | 牌号 | 剩余磁感应强度 $B_r$ KGs | 剩余磁感应强度 $B_r$ mT | 矫顽力 $H_{cB}$ kOe | 矫顽力 $H_{cB}$ kA/m | 内禀矫顽力 $H_{cJ}$ kOe | 内禀矫顽力 $H_{cJ}$ kA/m | 最大磁能积 $(Bh)_{max}$ MGOe | 最大磁能积 $(Bh)_{max}$ kJ/m³ | 剩磁/矫顽力 $B_r/\mu_0 H_{cB}$ - | 可逆温度系数 $\alpha_{m}$ (10-6/℃)(-55℃~150℃) | 最高工作温度 $T_m$ ℃ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 高性能 | XGS263/160/350 | 11.6±0.4 | 1160±40 | ≥10.4 | ≥828 | ≥20 | ≥1592 | 33±2 | 263±16 | 1.00~1.20 | −350±50 | 250 |
| | XGS263/199/350 | 11.6±0.4 | 1160±40 | ≥10.4 | ≥828 | ≥25 | ≥1989 | 33±2 | 263±16 | | −350±50 | 300 |
| | XGS255/160/350 | 11.5±0.4 | 1150±40 | ≥10.2 | ≥812 | ≥20 | ≥1592 | 32±2 | 255±16 | | −350±50 | 250 |
| | XGS255/199/350 | 11.5±0.4 | 1150±40 | ≥10.2 | ≥812 | ≥25 | ≥1989 | 32±2 | 255±16 | | −350±50 | 300 |
| | XGS247/160/350 | 11.4±0.4 | 1140±40 | ≥10.0 | ≥796 | ≥20 | ≥1592 | 31±2 | 247±16 | | −350±50 | 250 |
| | XGS247/199/350 | 11.4±0.4 | 1140±40 | ≥10.0 | ≥796 | ≥25 | ≥1989 | 31±2 | 247±16 | | −350±50 | 300 |
| | XGS247/239/350 | 11.4±0.4 | 1140±40 | ≥10.0 | ≥796 | ≥30 | ≥2387 | 31±2 | 247±16 | | −350±50 | 300 |
| | XGS239/160/350 | 11.2±0.4 | 1120±40 | ≥9.8 | ≥780 | ≥20 | ≥1592 | 30±2 | 239±16 | | −350±50 | 250 |
| | XGS239/199/350 | 11.2±0.4 | 1120±40 | ≥9.8 | ≥780 | ≥25 | ≥1989 | 30±2 | 239±16 | | −350±50 | 300 |
| | XGS239/239/350 | 11.2±0.4 | 1120±40 | ≥9.8 | ≥780 | ≥30 | ≥2387 | 30±2 | 239±16 | | −350±50 | 300 |
| | XGS223/160/350 | 10.8±0.4 | 1080±40 | ≥9.6 | ≥764 | ≥20 | ≥1592 | 28±2 | 223±16 | | −350±50 | 300 |
| | XGS223/199/350 | 10.8±0.4 | 1080±40 | ≥9.6 | ≥764 | ≥25 | ≥1989 | 28±2 | 223±16 | | −350±50 | 300 |
| | XGS223/239/350 | 10.8±0.4 | 1080±40 | ≥9.6 | ≥764 | ≥30 | ≥2387 | 28±2 | 223±16 | | −350±50 | 300 |
| | XGS223/279/350 | 10.8±0.4 | 1080±40 | ≥9.6 | ≥764 | ≥35 | ≥2785 | 28±2 | 223±16 | | −350±50 | 350 |
| | XGS208/160/350 | 10.5±0.4 | 1050±40 | ≥9.4 | ≥748 | ≥20 | ≥1592 | 26±2 | 208±16 | | −350±50 | 350 |
| 高工作温度 | XGS199/160G400 | 10.2±0.4 | 1020±40 | ≥9.3 | ≥740 | ≥20 | ≥1592 | 25±2 | 199±16 | 1.00~1.15 | −350±50 | 400 |
| | XGS191/160G450 | 10.0±0.4 | 1000±40 | ≥9.2 | ≥732 | ≥20 | ≥1592 | 24±2 | 191±16 | | −350±50 | 450 |
| | XGS183/199G500 | 9.8±0.4 | 980±40 | ≥9.1 | ≥724 | ≥25 | ≥1989 | 23±2 | 183±16 | | −350±50 | 500 |
| | XGS183/160G550 | 9.8±0.4 | 980±40 | ≥9.1 | ≥724 | ≥20 | ≥1592 | 22±2 | 183±16 | | −350±50 | 550 |
| 高稳定 | XGS127/199/80 | 8.0±0.4 | 800±40 | ≥7.5 | ≥597 | ≥25 | ≥1989 | 16±2 | 127±16 | | 优于−80 | 300 |
| | XGS143/199/100 | 8.5±0.4 | 850±40 | ≥7.8 | ≥621 | ≥25 | ≥1989 | 18±2 | 143±16 | | 优于−100 | 300 |
| | XGS159/199/100 | 9.2±0.4 | 920±40 | ≥8.2 | ≥652 | ≥25 | ≥1989 | 20±2 | 159±16 | 1.00~1.20 | 优于−100 | 300 |
| | XGS175/199/100 | 9.6±0.4 | 960±40 | ≥9.0 | ≥716 | ≥25 | ≥1989 | 22±2 | 175±16 | | 优于−110 | 250 |
| | XGS191/199/200 | 10.0±0.4 | 1000±40 | ≥9.2 | ≥732 | ≥25 | ≥1989 | 24±2 | 191±16 | | 优于−200 | 250 |
| 高温高稳定 | XGS143/199/150G450 | 8.5±0.4 | 850±40 | ≥7.8 | ≥621 | ≥25 | ≥1989 | 18±2 | 143±16 | 1.00~1.20 | −150±50 | 450 |
| | XGS127/199/100G450 | 8.0±0.4 | 800±40 | ≥7.5 | ≥597 | ≥25 | ≥1989 | 16±2 | 127±16 | | −100±50 | 450 |
| | XGS103/199/100G450 | 7.1±0.4 | 710±40 | ≥6.6 | ≥525 | ≥20 | ≥1592 | 13±2 | 103±16 | | −100±50 | 450 |
| 其他 | XGS175/160 | 9.6±0.4 | 960±40 | ≥9.0 | ≥716 | ≥20 | ≥1592 | 22±2 | 175±16 | 1.00~1.20 | −350±50 | 300 |
| | XGS159/160 | 9.2±0.4 | 920±40 | ≥8.2 | ≥652 | ≥20 | ≥1592 | 20±2 | 159±16 | 1.00~1.20 | −350±50 | 300 |
| | XGS48/160T | 5.7±0.3 | 570±30 | >5.0 | >398 | ≥20 | ≥1592 | $6_{0}^{+2}$ | $48_{0}^{+16}$ | 1.00~1.20 | −350±50 | 250 |

注：用户可根据使用情况订购高内禀矫顽力、低内禀矫顽力、内禀矫顽力为范围值等产品

## NIM-500 CHYSTERESIGRAPH TEST REPORT

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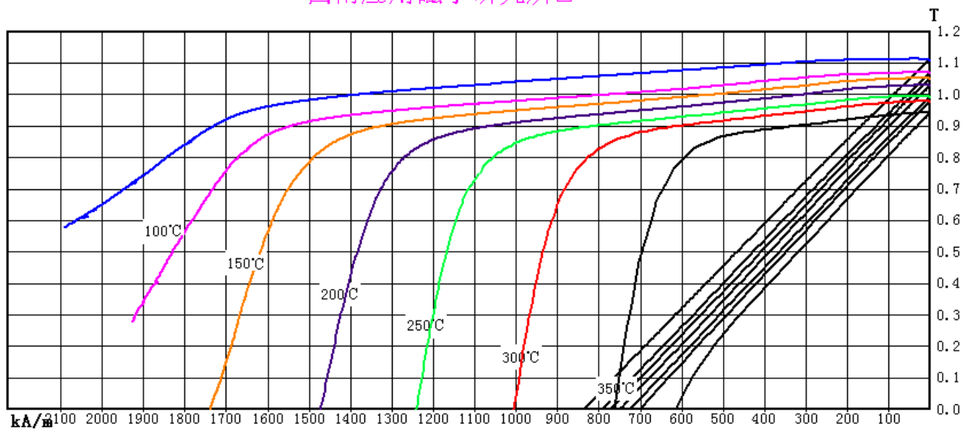


XGS239/199/350材料典型高温退磁曲线
Demagnetization curve of grade XGS239/199/350

| 温度 ℃ | 剩磁Br | | 内禀矫顽力$H_{cJ}$ | | 矫顽力$H_{cB}$ | | 最大磁能积$(BH)_{max}$ | |
|---|---|---|---|---|---|---|---|---|
| | kGs | T | kOe | kA/m | kOe | kA/m | MGOe | kJ/m³ |
| 常温 | 11.0 | 1.10 | 26.4 | 2103 | 10.4 | 828 | 28.9 | 230 |
| 100 | 10.7 | 1.07 | 24.3 | 1929 | 10.0 | 794 | 27.1 | 216 |
| 150 | 10.5 | 1.05 | 22.0 | 1739 | 9.7 | 774 | 25.8 | 205 |
| 200 | 10.3 | 1.03 | 18.5 | 1472 | 9.4 | 750 | 24.5 | 195 |
| 250 | 9.9 | 0.99 | 15.6 | 1241 | 9.1 | 726 | 23.0 | 183 |
| 300 | 9.8 | 0.98 | 12.6 | 1005 | 8.8 | 701 | 21.9 | 175 |
| 350 | 9.4 | 0.94 | 9.6 | 764 | 7.7 | 615 | 20.1 | 160 |



Product Manual 稀土永磁材料及器件产品手册

## NIM-500 CHYSTERESIGRAPH TEST REPORT

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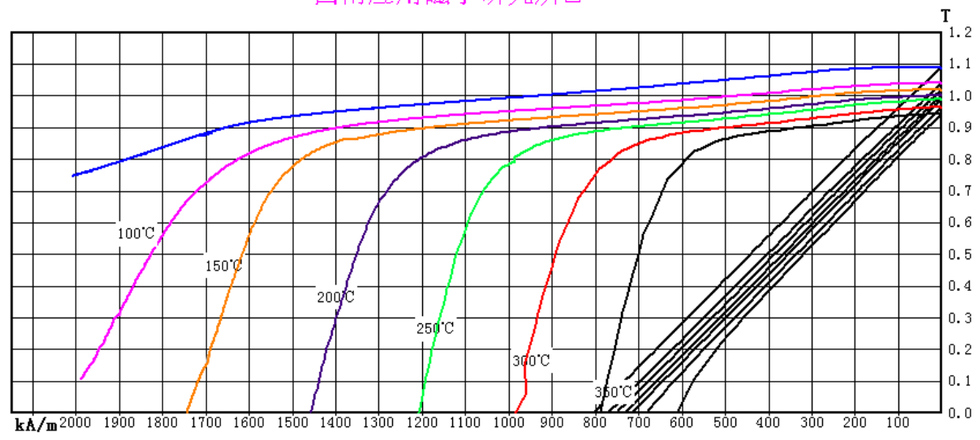



XGS223/199/350材料典型高温退磁曲线
Demagnetization curve of grade XGS223/199/350

| 温度 ℃ | 剩磁Br | | 内禀矫顽力$H_{cJ}$ | | 矫顽力$H_{cB}$ | | 最大磁能积$(BH)_{max}$ | |
|---|---|---|---|---|---|---|---|---|
| | kGs | T | kOe | kA/m | kOe | kA/m | MGOe | kJ/m³ |
| 常温 | 10.9 | 1.09 | 25.2 | 2009 | 10.1 | 806 | 28.1 | 224 |
| 100 | 10.4 | 1.04 | 25.0 | 1987 | 9.7 | 772 | 25.5 | 203 |
| 150 | 10.2 | 1.02 | 21.9 | 1743 | 9.5 | 752 | 24.3 | 193 |
| 200 | 10.0 | 1.00 | 18.3 | 1459 | 9.2 | 733 | 23.2 | 185 |
| 250 | 9.9 | 0.99 | 15.2 | 1208 | 9.0 | 717 | 22.4 | 178 |
| 300 | 9.6 | 0.96 | 12.4 | 984 | 8.6 | 683 | 21.2 | 168 |
| 350 | 9.4 | 0.94 | 9.9 | 790 | 7.7 | 612 | 20.0 | 160 |

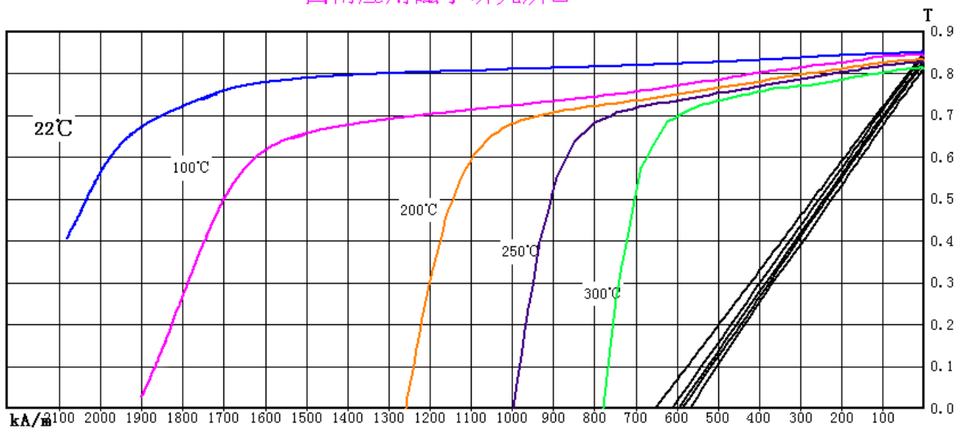
# 高稳定稀土钴永磁材料 High Stability Rare Earth Cobalt Permanent Magnet Materials

高稳定稀土钴永磁材料具有更低的温度系数，高内禀矫顽力，时间稳定性更好等特点。适用于对磁场稳定性要求高的惯导器件、电真空器件等。

High Stability Rare Earth Cobalt Permanent Magnet Materials has the characteristics of lower temperature coefficient, high intrinsic coercive force, better time stability. It is suitable for inertial navigation devices and electric vacuum devices, etc.

## NIM-500 CHYSTERESIGRAPH TEST REPORT

西南应用磁学研究所□




XGS127/199/80材料典型高温退磁曲线
Demagnetization curve of grade XGS127/199/80

| 温度 ℃ | 剩磁Br | | 内禀矫顽力$H_{cJ}$ | | 矫顽力$H_{cB}$ | | 最大磁能积$(BH)_{max}$ | |
|---|---|---|---|---|---|---|---|---|
| | kGs | T | kOe | kA/m | kOe | kA/m | MGOe | kJ/m³ |
| 常温 | 8.4 | 0.84 | 26.1 | 2080 | 8.1 | 641 | 16.2 | 129 |
| 100 | 8.3 | 0.83 | 23.9 | 1901 | 7.5 | 600 | 15.6 | 124 |
| 200 | 8.2 | 0.82 | 15.8 | 1259 | 7.4 | 586 | 15.1 | 120 |
| 250 | 8.1 | 0.81 | 12.5 | 998 | 7.2 | 576 | 14.7 | 117 |
| 300 | 8.0 | 0.80 | 9.8 | 780 | 7.0 | 557 | 13.9 | 111 |





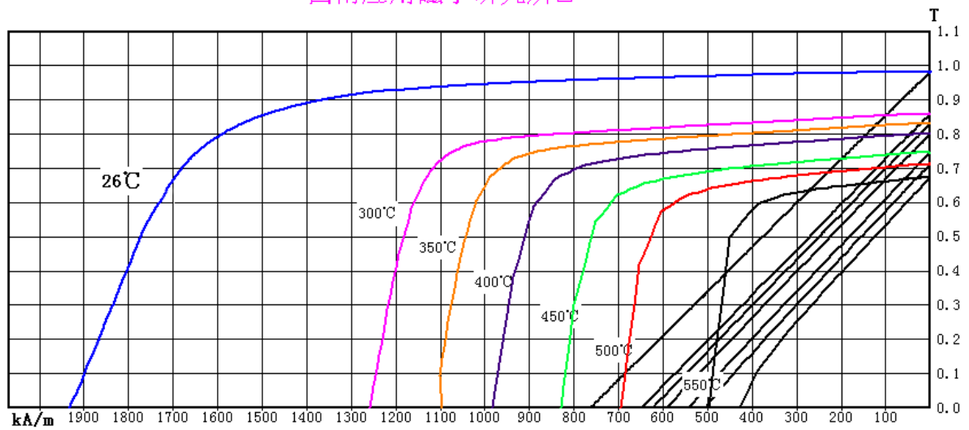
# 高工作温度稀土钴永磁材料系列 High Operating Temperature Rare Earth Cobalt Permanent Magnet Materials

高工作温度稀土钴永磁材料可以在特别高的温度下工作。适用于要求400~550℃下工作的多电飞机作动器、磁悬浮轴承、离子推进、大功率电真空器件、高温传感器等应用。

High Operating Temperature Rare Earth Cobalt Permanent Magnet Materials can Operating at very high temperature, 400~550℃. It is suitable for Ion propulsion, high power electric vacuum devices, high temperature sensors, etc.

## NIM-500 CHYSTERESIGRAPH TEST REPORT

西南应用磁学研究所□




XGS183/199/G500材料典型高温退磁曲线
Demagnetization curve of grade XGS183/199/G500

| 温度 ℃ | 剩磁Br | | 内禀矫顽力$H_{cJ}$ | | 矫顽力$H_{cB}$ | | 最大磁能积$(BH)_{max}$ | |
|---|---|---|---|---|---|---|---|---|
| | kGs | T | kOe | kA/m | kOe | kA/m | MGOe | kJ/m³ |
| 常温 | 9.8 | 0.98 | 24.3 | 1933 | 9.6 | 764 | 23.8 | 189 |
| 300 | 8.6 | 0.86 | 15.8 | 1260 | 8.2 | 649 | 17.6 | 140 |
| 400 | 8.0 | 0.80 | 12.4 | 985 | 7.3 | 584 | 15.1 | 120 |
| 500 | 7.2 | 0.72 | 8.7 | 696 | 6.4 | 507 | 11.7 | 93 |
| 550 | 6.8 | 0.68 | 6.3 | 499 | 5.4 | 427 | 10.3 | 82 |

# 烧结钕铁硼永磁材料性能参数表 Sintered NdFeB

| 牌号 | 剩余磁感应强度 $B_r$ | | 矫顽力 $H_{cB}$ | | 内禀矫顽力 $H_{cJ}$ | | 最大磁能积 $(BH)_{max}$ | | 最高工作温度 $T_m$ |
|---|---|---|---|---|---|---|---|---|---|
| | kGs | mT | kOe | kA/m | kOe | kA/m | MGOe | kJ/m³ | ℃ |
| N45 | 13.6 $^{+0.2}_{-0.4}$ | 1360 $^{+20}_{-40}$ | ≥10.5 | ≥836 | ≥12 | ≥955 | 45 $^{+1}_{-3}$ | 358 $^{+8}_{-24}$ | 80 |
| N48 | 14.0 $^{+0.3}_{-0.4}$ | 1400 $^{+30}_{-40}$ | ≥10.5 | ≥836 | ≥12 | ≥955 | 48 $^{+1}_{-3}$ | 382 $^{+8}_{-24}$ | 80 |
| N53 | 14.8 $^{+0.2}_{-0.4}$ | 1480 $^{+20}_{-40}$ | ≥10.5 | ≥836 | ≥11 | ≥876 | 53 $^{+1}_{-3}$ | 422 $^{+8}_{-24}$ | 80 |
| N54M | 15.0 $^{+0.2}_{-0.4}$ | 1500 $^{+20}_{-40}$ | ≥10.5 | ≥836 | ≥13 | ≥1035 | 54 $^{+1}_{-3}$ | 430 $^{+8}_{-24}$ | 100 |
| N45M | 13.6 $^{+0.2}_{-0.4}$ | 1360 $^{+20}_{-40}$ | ≥12.2 | ≥976 | ≥14 | ≥1114 | 45 $^{+1}_{-3}$ | 358 $^{+8}_{-24}$ | 100 |
| N48M | 14.0 $^{+0.3}_{-0.4}$ | 1400 $^{+30}_{-40}$ | ≥12.7 | ≥1012 | ≥14 | ≥1114 | 48 $^{+1}_{-3}$ | 382 $^{+8}_{-24}$ | 100 |
| N45H | 13.6 $^{+0.2}_{-0.4}$ | 1360 $^{+20}_{-40}$ | ≥12.2 | ≥976 | ≥17 | ≥1353 | 45 $^{+1}_{-3}$ | 358 $^{+8}_{-24}$ | 120 |
| N35SH | 12.1±0.2 | 1210±20 | ≥10.6 | ≥845 | ≥20 | ≥1592 | 35±2 | 279±16 | 150 |
| N38SH | 12.6±0.2 | 1260±20 | ≥11.1 | ≥886 | ≥20 | ≥1592 | 38±2 | 302±16 | 150 |
| N40SH | 12.9±0.2 | 1290±20 | ≥11.5 | ≥912 | ≥20 | ≥1592 | 40±2 | 318±16 | 150 |
| N42SH | 13.2±0.2 | 1320±20 | ≥11.8 | ≥938 | ≥20 | ≥1592 | 42±2 | 334±16 | 150 |
| N44SH | 13.6±0.2 | 1360±20 | ≥12.2 | ≥976 | ≥20 | ≥1592 | 44±2 | 350±16 | 150 |
| N52SH | 14.2±0.2 | 1420±20 | ≥12.8 | ≥1035 | ≥20 | ≥1592 | 52±2 | 414±16 | 150 |
| N33UH | 11.6±0.2 | 1160±20 | ≥10.3 | ≥820 | ≥25 | ≥1990 | 33±2 | 263±16 | 180 |
| N35UH | 12.0±0.2 | 1200±20 | ≥10.6 | ≥845 | ≥25 | ≥1990 | 35±2 | 279±16 | 180 |
| N38UH | 12.5±0.2 | 1250±20 | ≥11.1 | ≥886 | ≥25 | ≥1990 | 38±2 | 302±16 | 180 |
| N40UH | 12.9±0.2 | 1290±20 | ≥11.5 | ≥912 | ≥25 | ≥1990 | 40±2 | 318±16 | 180 |
| N42UH | 13.2±0.2 | 1320±20 | ≥11.8 | ≥938 | ≥25 | ≥1990 | 42±2 | 334±16 | 180 |
| N45UH | 13.5±0.2 | 1350±20 | ≥12.2 | ≥976 | ≥25 | ≥1990 | 45±2 | 358±16 | 180 |
| N50UH | 13.9±0.2 | 1390±20 | ≥12.8 | ≥1035 | ≥25 | ≥1990 | 50±2 | 398±16 | 180 |
| N33EH | 11.6±0.2 | 1160±20 | ≥10.2 | ≥816 | ≥30 | ≥2387 | 33±2 | 263±16 | 200 |
| N35EH | 12.0±0.2 | 1200±20 | ≥10.6 | ≥845 | ≥30 | ≥2387 | 35±2 | 279±16 | 200 |
| N38EH | 12.5±0.2 | 1250±20 | ≥11.1 | ≥886 | ≥30 | ≥2387 | 38 $^{+1}_{-3}$ | 302 $^{+8}_{-24}$ | 200 |
| N44EH | 13.5±0.2 | 1350±20 | ≥12.2 | ≥976 | ≥30 | ≥2387 | 44 $^{+1}_{-3}$ | 366 $^{+8}_{-24}$ | 200 |



Product Manual 稀土永磁材料及器件产品手册

# 稀土永磁材料典型电磁性能和机械性能 Typical electromagnetic and mechanical properties of rare earth permanent magnet materials

稀土永磁材料典型机械性能和电磁性能不作考核依据，仅供元件设计时参考。这一类材料性脆，缺乏可塑性，设计时不应用作结构件。

Rare earth permanent magnet materials lack ductility and are inherently brittle. such materials should not be utilized as structural components. Typical mechanical properties and electromagnetic properties are shown blow only for reference in design.

## 典型电磁性能（典型值）Typical Electromagnetic Properties - Typical Value

| 电磁性能Electromagnetic Properties | NdFeB | $RECo_5$ | $RE_2Co_{17}$ |
|---|---|---|---|
| 内禀矫顽力温度系数β (%/℃)<br>Temperature Coefficient of intrinsic coercive force | -0.45~ -0.65 | -0.3 | -0.025 |
| 剩磁温度系数α (%/℃)<br>Temperature Coefficient of remanence | -0.095~-0.124 | -0.045 | -0.035 |
| 磁化磁场 (kA/m) Magnetizing Field | ≥1989 | ≥1600 | ≥3200 |
| 回复磁导率 Recoil Permeability | 1.05 | 1.05 | 1.05～1.1 |
| 居里温度 (℃) Curie Temperature | 320 | 700 | 820 |
| 电阻率（$\times10^{-6}\Omega\cdot$cm）Electrical Resistivity | 130 | 52 | 86 |

## 典型机械性能（典型值）Typical Mechanical Properties - Typical Value

| 机械性能 Mechanical Properties | NdFeB | $RECo_5$ | $RE_2Co_{17}$ |
|---|---|---|---|
| 密度（g/cm³） Density | 7.4~7.5 | 8.1~8.5 | 8.3~8.5 |
| 韦氏硬度HV Vickers Hardness | 550~650 | 610～670 | 510～600 |
| 压缩强度$\sigma_c$（Mpa）Compressive Strength | 1100 | ～420 | ～650 |
| 拉伸强度$\sigma_b$（Mpa） Tensile Strength | 75 | ～41 | 15～25 |
| 弯曲强度$\sigma_a$（MPa） Flexural Strength | 250 | ～90 | ～120 |
| 断裂韧性KIC（Mpa·m$^{1/2}$） Fracture Toughness | | | 1.5~2.0 |
| 杨氏模量($10^5$ Mpa) Young’s Modulus | 1.5 | 1.2 | 1.1 |
| 热导率 (W/mK) Thermal Conductivity | 8~10 | | 23 |
| 热膨胀系数（平行于取向方向）($10^{-6}$/℃)<br>Coefficient of Thermal Expansion<br>(Parallel to Orientation) | 5.2 | 7 | 8 |
| 热膨胀系数（垂直于取向方向）($10^{-6}$/℃)<br>Coefficient of Thermal Expansion<br>(Perpendicular to Orientation) | -0.8 | 13 | 11 |

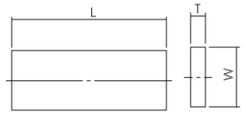
## 永磁元件 Component

永磁元件指用各种机械加工方法将永磁材料加工成不同形状和尺寸的永磁体。机械加工工艺包括线切割、磨加工、切片加工和打孔等。

Permanent magnet component refers to permanent magnet materials processed into permanent magnets of different shapes and sizes by various machining methods. Machanical addition techniques include wire-cutting, grinding, slicing and punching.

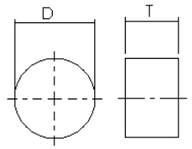
### 典型产品规格 Typical product specifications

方形 Square



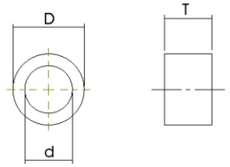

L: 1~150mm 可为磁化方向
W: 1~60mm可为磁化方向
T: 1~60mm可为磁化方向

圆形 Circle



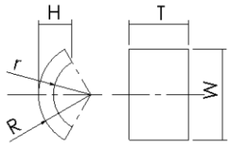

D: 1~120mm可为磁化方向
T: 1~50mm可为磁化方向

圆环 Annulus



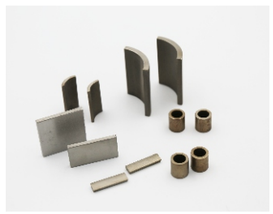

D: 1~120mm 可为磁化方向
d: 1~50mm
T: 1~50mm可为磁化方向

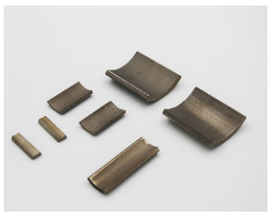
瓦形 Tile shape




W: 1~60mm
T: 0.5~80mm可为磁化方向
H: 2~80mm可为磁化方向

注: 异形和辐向磁化环形、辐向磁化瓦形尺寸可根据用户要求加工。
Notice: The size of other abnormal shape, radial magnetized ring and radial magnetic arc magnets need to be discussed again.







## 永磁元件表面处理 Surface treatment for magnet

稀土钴永磁材料一般无需表面处理, 高温使用(400℃以上)应进行表面处理。钕铁硼永磁材料必须表面处理。

Generally, rare earth cobalt permanent magnets should not be surface treatment and must be surface treatment in high temperature environment (400℃above), while neodymium iron boron permanent magnets should be surface treatment.

| 表面处理 Surface treatment | 厚度 (μm) Thickness | 特性 Characteristics | 应用 Application |
|---|---|---|---|
| 镀镍 Nickel coating | 10~20 | 抗腐蚀好 Excellent corrosion resistance | 电机振动传感器 Motors sensors wigglers |
| 镀锌 Zinc coating | 15~20 | 抗腐蚀较好 Good corrosion resistance | 电机、传感器 motors, sensors |
| 高分子涂敷 Parylene coating | 5~20 | 耐盐雾特别优异 Excellent salt fog resistance | 各种电机 Various motors |
| 电泳 Epoxy coating | 20~30 | 耐盐雾, 绝缘好 Good salt fog resistance and insulation | 其他设备 Other Devices |

电镀

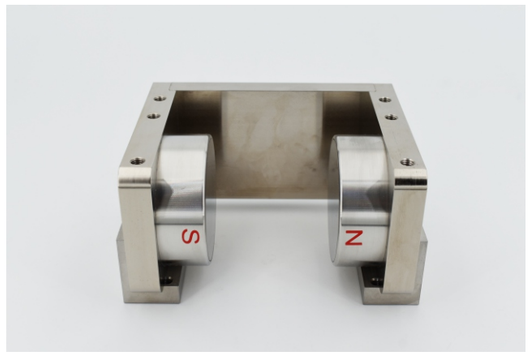
电泳

# 永磁组件 Permanent magnet components

永磁组件是由永磁元件与其它金属、合金或软磁材料一起组成的磁结构，以产生一定功能，如产生气隙磁场、形成周期变化的磁场分布等。九所在永磁组件的设计方面经验丰富，可以根据用户要求进行仿真设计。设计制造的永磁组件包括：磁控管永磁组件、电机用永磁组件、离子谱仪永磁组件、磁致伸缩永磁组件、磁力耦合器等。

A permanent component is a magnetic structure composed of a permanent magnet component and other metals, alloys or soft magnetic materials to produce certain functions,such as generating an air gap magnetic field, forming a magnetic field distribution with periodic changes, etc.Experienced in the design of permanent magnet assemblies, SIAM can carry out simulation design according to customer requirements. Permanent magnet assembly that we have designed and manufactured: Permanent magnet assembly for magnetron, permanent magnet assembly for motor, assembly for ion spectrometer ,assembly for magnetostrictive transducer, permanent magnetic wiggler and so on.

## 磁控管永磁组件系列 Magnetron permanent magnet assembly series





| 系列 Series | 代表型号 Representative number | 气隙中心磁场强度 Strength of magnetic field at the center of the air gap |
|---|---|---|
| 1650GS 磁控管永磁组件 1650GS magnetron permanent magnet assembly series | JMM201603B | 165.0±2.5mT |
| 1630Gs磁控管永磁组件 1630Gs magnetron permanent magnet assembly series | MG7095(JMM201504A) | 163.0-165.0 mT |
| 1550Gs磁控管永磁组件 1550Gs magnetron permanent magnet assembly series | 5193（JMM200201） | 155.0±2.5mT |
| 1490GS磁控管永磁组件 1490GS magnetron permanent magnet assembly series | 5125(JMM201701A) | 149.0±2.5mT |
| 1400GS磁控管永磁组件 1400GS magnetron permanent magnet assembly series | JMM201306B | 140.0±2.5mT |
| 1280GS磁控管永磁组件 1280GS magnetron permanent magnet assembly series | JMM201406B | 128.0±2.5mT |
| 1200GS磁控管永磁组件 1200GS magnetron permanent magnet assembly series | JMM201602B | 120.0±2.5mT |
| 1100GS磁控管永磁组件 1100GS magnetron permanent magnet assembly series | JMM201710A | 110.0±2.5mT |

注：可根据用户需求设计气隙中心磁场强度
Notice: Air gap center magnetic field strength can be designed according to user requirements.

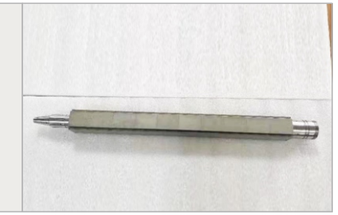
# 其他永磁组件 Other permanent magnet components

| 产品名称 Name | 主要性能 Performance | 指标特点或用途 Indicator characteristics or purposes |
|---|---|---|
| 斯特林制冷机永磁组件<br>Stirling refrigerator permanent magnet components | 1、产品重量不大于400 g<br>2、磁通≥3.47×$10^{-4}$ Wb<br>3、在极限工作温度(−40和71 ℃)下磁钢组件的磁通的变化率小于5%<br>1.The weight of the product is not more than 400g.<br>2.Magnetic flux ≥3.47×$10^{-4}$ Wb<br>3.At the limit temperature,the flux change rate of magnetic steel components is less than 5%. | Pt-Si红外探测器中<br>Pt-Si infrared detector |
| 粒子谱仪用永磁组件<br>Permanent magnet assembly for ion spectrometer | 磁场强度:100～10000 Oe<br>均匀性:±1～5%（根据要求选择）<br>Strength of magnetic field: 100～10000 Oe<br>Uniformity: ±1～5%(select on request) | / |
| 电子谱仪用永磁组件<br>Permanent magnet components for electronic spectrometers | 磁场强度:100～10000 Oe<br>均匀性:±1～5%（根据要求选择）<br>Strength of magnetic field: 100～10000 Oe<br>Uniformity: ±1～5%(select on request) | / |
| 永磁磁力打捞器<br>Suction device | 吸力13kg/$cm^2$<br>Suction 13kg/$cm^2$ | 具有使用温度高,吸力大的特点。适用于石油钻井钻头的打捞。<br>It has the characteristics of high temperature and large suction. Suitable for oil drilling bit fishing. |
| 磁制冷用永磁组件<br>Permanent magnet components for magnetic refrigeration | 磁场强度:16000 Oe<br>磁场均匀性:±5%<br>Strength of magnetic field: 100～10000 Oe<br>Uniformity: ±5% | 磁场强度特别高,磁场均匀。<br>The strength of magnetic field is particularly strong and the magnetic field uniformity. |
| 注:可根据用户需求进行设计　Note: Can be designed according to user needs | | |

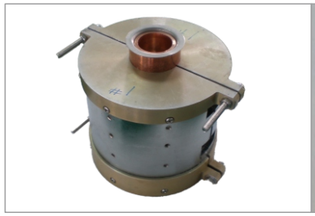


Product Manual 稀土永磁材料及器件产品手册

离子谱仪永磁组件Permanent magnet assembly for ion spectrometer



转子组件 Rotor assembly



速调管永磁组件 Permanent magnet assembly for klystron

永磁聚焦系统结构 PPM for TWT

磁力打捞器 Suction device

## 注意事项 Notice

**1.稀土永磁材料(特别是稀土钴永磁材料)性质脆,不宜用作结构件。**
Rare earth permanent magnet materials (especially rare earth cobalt permanent magnet materials) are brittle in nature and should not be designed as structure components

**2.加工与公差 Manufacturing and Tolerance**
经磨加工后的永磁体公差通常为±0.05,或更精密的±0.02mm。
Grilling tolerance is usually ±0.05, ±0.02mm is achievable and costs more.

**3.供货状态 Supplying Status**
永磁体根据用户要求以两种状态供货:磁化状态和未磁化状态,通常不标明磁极。如用户声明,可以用双方商定的方式标明极性。在签定合同时,用户应确定是否磁化和标明极性。
Permanent magnets are supplied in two statuses: magnetized and un-magnetized. Usually magnetic poles are not marked. Users should declare in the order on whether to magnetize or mark the magnet.

# 单位制换算 Translation of Unit System

| 物理量 | 符号 | 高斯单位制(CGS) | 国际单位制(SI) | 换算 |
|---|---|---|---|---|
| 磁场强度 | H | Oe | A/m | 1 Oe = $\frac{1000}{4\pi}$ A/m |
| 磁感应强度 | B | Gs | T | 1 Gs = $10^{-4}$ T |
| 磁能积 | $(BH)_{max}$ | GOe | $J/m^3$ | 1 MGOe = $\frac{100}{4\pi}$ $kJ/m^3$ |
| 磁通 | ϕ | Mx | Wb | 1 Mx=$10^{-8}$ Wb |
| 备注 | 1 T=1000 mT, 1 MGOe=$10^6$G Oe, 1kJ/$m^3$=1000J/$m^3$ | | | |