目　录 CONTENTS

电工钢发展历史 Electrical Steel Developing History

2003 年，薄板坯连铸连轧生产线（CSP）投产；

2005 年，半工艺冷轧无取向电工钢批量生产；

2007 年，硅钢一期全工艺冷轧无取向电工钢生产线投产（40 万吨）；

2007 年，全工艺冷轧无取向电工钢批量化生产；

2012 年，硅钢二期高牌号冷轧无取向电工钢生产线投产（15 万吨）；

2015 年，高牌号冷轧无取向电工钢批量化生产；

2016 年，新能源汽车用冷轧无取向电工钢批量化生产。

In 2003, the thin slab continuous casting and rolling production line (CSP) put into operation;

In 2005, semi-process cold-rolled non-oriented electrical steel has being mass produced;

In 2007, 1st production line for Full-process cold-rolled non-oriented electrical steel put into production (400,000 tons);

In 2007, Full-process cold-rolled non-oriented electrical steel has being mass produced;

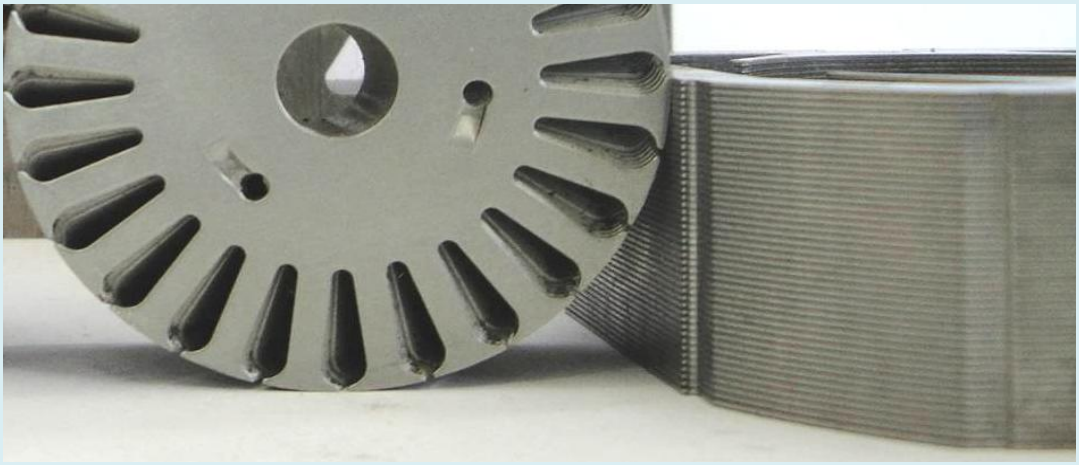
In 2012, 2st production line for high grades Full-process cold-rolled non-oriented electrical steel put into production (150,000 tons);

In 2015, high grades cold-rolled non-oriented electrical steel has being mass produced;

In 2016, the cold-rolled non-oriented electrical steel for new energy vehicle has being mass produced.

产品特点 Product Characteristics

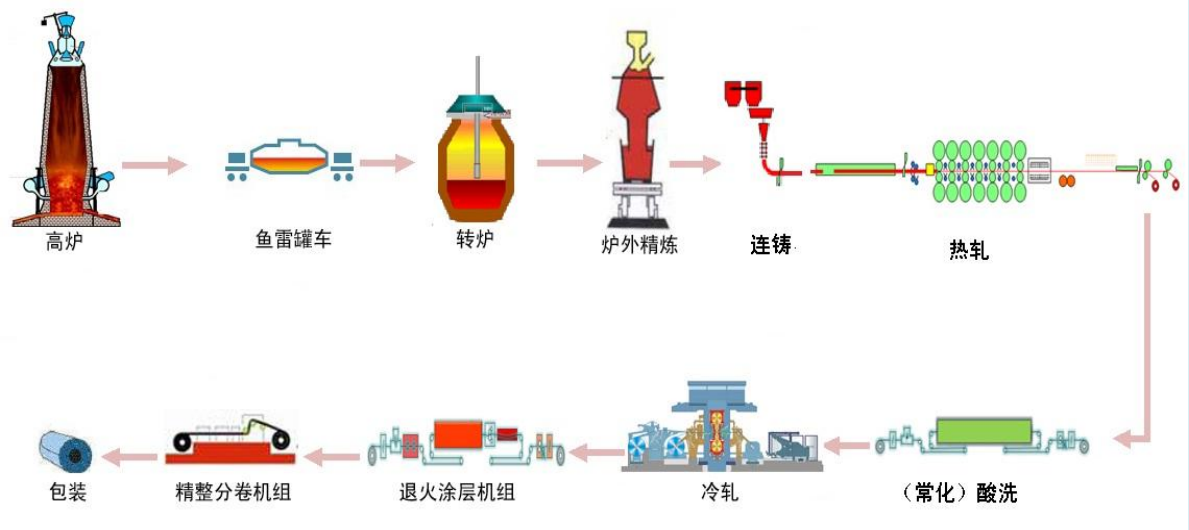
- **性能稳定 Stable performance**
- **加工性能优越：**高精度的尺寸和优异的力学性能便于剪切、冲压和叠片，钢带适用于高速冲裁，焊接性能优良。
- **Excellent processing performance:** High precision dimension and excellent mechanical properties make it easy to be sheared, punched and stacked by high speed punch machine. It also have good welding performance.
- **绝缘涂层性能优良：**色泽均匀、绝缘性好、附着力强、耐热性能优良、加工性能优异。马钢电工钢绝缘涂层具有优良的层间绝缘性能、附着性、冲片性、耐热性及焊接性。
- **Excellent performance of Insulating coating:** Uniform color, good insulation, high adhesion, excellent heat resistance and excellent processing performance.



1 生产工艺 Manufacturing Process

马钢无取向电工钢生产工艺流程和关键工序示意图。

Schematic diagram shows the key manufacturing process of non-oriented electrical steel in Masteel.



2 全工艺无取向电工钢 Full-Processed Non-Oriented Electrical Steel

2.1 产品标准尺寸 Standard Size of Products

厚度 Thickness	0.27mm、0.30mm、0.35mm、0.50mm、
宽度 Width	900mm～1230mm
钢卷内径 Coil inner dia	508mm、610mm

2.2 尺寸及板形公差 Size and Shape Tolerance

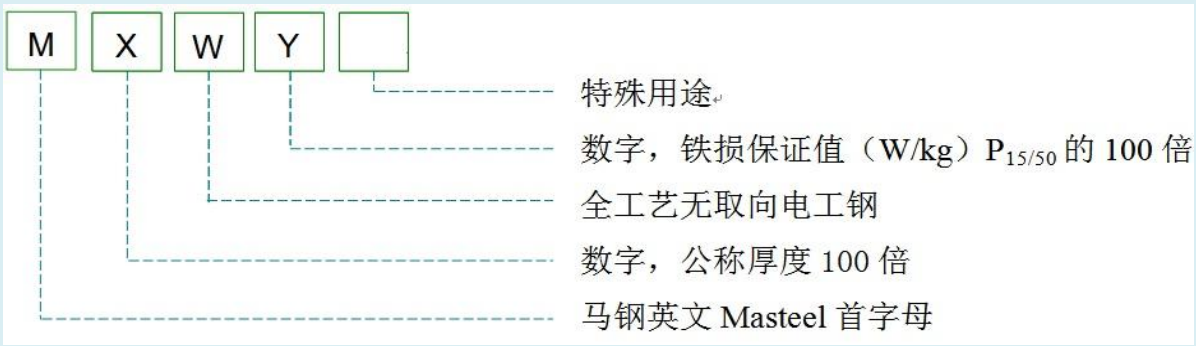
公称宽度 Nominal width（mm）	公称厚度 Nominal thickness（mm）	厚度允许偏差 Thickness allowable deviation（mm）	横向厚度差 Transverse thickness difference（mm）	宽度允许偏差 Width allowable deviation（mm）	
				不切边 Non trimming	切边 trimming
＞500～1000	0.27	±0.020	≤0.020	+5.0 0	+1.0 0
	0.30	±0.020	≤0.020		
	0.35	±0.020	≤0.020		
	0.50	±0.030	≤0.020		
＞1000	0.27	±0.020	≤0.020	+5.0 0	+1.5 0
	0.30	±0.020	≤0.020		
	0.35	±0.030	≤0.020		
	0.50	±0.030	≤0.030		

注：对于有特殊要求的用户，马钢可以标准+α供货。

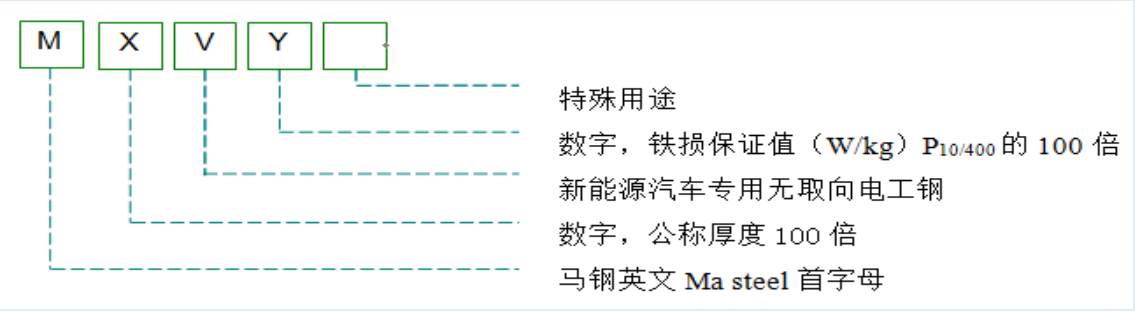
Note: When the users have special demands, the method of standard +α can be used to supply materials by Masteel.

2.3 产品牌号的表示方法 Representing method of non-oriented electrical steel

✪ 普通无取向电工钢 Common Grade Non-oriented Electrical Steel



✪ 新能源汽车用无取向电工钢 Non-oriented Electrical Steel for New Energy Vehicle



2.4 电磁性能标准 Electron-magnetic Properties Standard

✪ 普通无取向电工钢 Common grade non-oriented electrical steel

牌号 Grade	公称厚度 Nominal width mm	理论密度 Theoretical density kg/dm^3	铁损 $P_{1.5/50}$ Iron loss W/kg	磁感 B_{50} Magnetic strength T	叠装系数 Stacking factor %
M35W230	0.35	7.60	≤2.30	≥1.62	≥95
M35W250		7.60	≤2.50	≥1.62	≥95
M35W270		7.65	≤2.70	≥1.62	≥95
M35W300		7.65	≤3.00	≥1.62	≥95
M35W360		7.65	≤3.60	≥1.62	≥95
M35W440		7.70	≤4.40	≥1.64	≥95
M35W550		7.75	≤5.50	≥1.64	≥97
M50W250	0.50	7.60	≤2.50	≥1.62	≥97
M50W270		7.60	≤2.70	≥1.62	≥97
M50W290		7.60	≤2.90	≥1.62	≥97
M50W310		7.65	≤3.10	≥1.62	≥97
M50W330		7.65	≤3.30	≥1.62	≥97
M50W350		7.65	≤3.50	≥1.62	≥97
M50W400		7.70	≤4.00	≥1.63	≥97
M50W470		7.70	≤4.70	≥1.64	≥97
M50W600		7.75	≤6.00	≥1.66	≥97
M50W800		7.80	≤8.00	≥1.70	≥97
M50W1000		7.85	≤10.00	≥1.72	≥97
M50W1300(D)		7.85	≤13.00	≥1.74	≥97

✪ 新能源汽车用无取向电工钢 Non-oriented Electrical Steel for New Energy Vehicle

牌号 Grade	公称厚度 Nominal width mm	理论密度 Theoretical density kg/dm^3	铁损 $P_{1.0/40}$ Iron loss W/kg	磁感 B_{50} Magnetic strength T	叠装系数 Stacking factor %
M35V2100	0.35	7.65	≤21.00	≥1.63	≥95
M35V1900		7.65	≤19.00	≥1.62	≥95
M35V1700		7.60	≤17.00	≥1.62	≥95
M30V1800	0.30	7.65	≤18.00	≥1.63	≥95
M30V1700		7.65	≤17.00	≥1.62	≥95
M30V1600		7.60	≤16.00	≥1.62	≥95
M27V1500	0.27	7.60	≤15.00	≥1.62	≥95

✪ 高效无取向电工钢 High Efficiency Non-oriented Electrical Steel

牌号 Grade	公称厚度 Nominal width mm	理论密度 Theoretical density kg/dm^3	铁损 $P_{1.5/50}$ Iron loss W/kg	磁感 B_{50} Magnetic strength T	叠装系数 Stacking factor %
M50W600-H	0.50	7.75	≤6.00	≥1.68	≥97
M50W470H	0.50	7.75	≤4.70	≥1.71	≥97

2.5 典型电磁性能 Typical Electron-magnetic Properties

✪ 普通无取向电工钢 Common grade non-oriented electrical steel

牌号 Grade	公称厚度 Nominal width mm	理论密度 Theoretical density kg/dm^3	铁损 $P_{1.5/50}$ Iron loss W/kg	磁感 B_{50} Magnetic strength T
M35W230	0.35	7.60	2.15	1.66
M35W250		7.60	2.30	1.65
M35W270		7.65	2.35	1.67
M35W300		7.65	2.50	1.68
M35W360		7.65	2.80	1.68
M35W440		7.70	3.00	1.68
M35W550		7.75	3.30	1.79
M50W250	0.5	7.60	2.45	1.65
M50W270		7.60	2.50	1.66
M50W290		7.60	2.60	1.67
M50W310		7.65	2.70	1.68
M50W350		7.65	2.80	1.68
M50W400		7.70	3.00	1.69
M50W470		7.70	3.30	1.70
M50W600		7.75	3.90	1.70
M50W800		7.80	4.80	1.72
M50W1000		7.85	5.30	1.73
M50W1300(D)		7.85	5.50	1.76

✪ 新能源汽车用无取向电工钢 Non-oriented Electrical Steel for New Energy Vehicle

牌号 Grade	公称厚度 Nominal width mm	理论密度 Theoretical density kg/dm^3	铁损 $P_{1.0/400}$ Iron loss W/kg	磁感 B_{50} Magnetic strength T
M35V2100	0.35	7.65	18.50	1.68
M35V1900		7.65	17.50	1.66
M35V1700		7.60	16.50	1.65
M30V1800	0.30	7.65	17.00	1.66
M30V1700		7.65	16.30	1.65
M30V1600		7.60	15.30	1.64
M27V1500	0.27	7.60	14.00	1.64

✪ 高效无取向电工钢 High Efficiency Non-oriented Electrical Steel

牌号 Grade	公称厚度 Nominal width mm	理论密度 Theoretical density kg/dm^3	铁损 $P_{1.5/50}$ Iron loss W/kg	磁感 B_{50} Magnetic strength T
M50W600-H	0.50	7.75	3.30	1.72
M50W470H	0.50	7.75	3.10	1.73

2.6 典型力学性能 Typical Mechanical Properties

✪ 普通无取向电工钢 Common grade non-oriented electrical steel

牌号 Grade	公称厚度 Nominal width mm	屈服强度 Yeild Strength N/mm^2	抗拉强度 Ultra-Tension Strength N/mm^2	延伸率 Ductility %	硬度 Hardness HV1
M35W230	0.35	430	560	20.0	225
M35W250		415	550	20.5	220
M35W270		400	515	20.5	215
M35W300		360	480	21.5	195
M35W360		350	480	23.5	190
M35W440		275	420	27.5	165
M35W550		265	415	33.5	160
M50W250	0.5	430	560	19.0	230
M50W270		410	550	21.5	225
M50W290		395	545	22.5	220
M50W310		385	510	24.5	210
M50W350		350	475	26.5	190
M50W400		320	460	36.0	170
M50W470		295	425	35.0	160
M50W600		280	410	37.0	140
M50W800		285	405	38.5	135
M50W1300(D)		250	360	40.0	115

✪ 新能源汽车用无取向电工钢 Non-oriented Electrical Steel for New Energy Vehicle

牌号 Grade	公称厚度 Nominal width mm	屈服强度 Yeild Strength N/mm^2	抗拉强度 Ultra-Tension Strength N/mm^2	延伸率 Ductility %	硬度 Hardness HV1
M35V2100	0.35	365	485	22.0	195
M35V1900		400	520	21.0	210
M35V1700		430	550	20.0	215
M30V1800	0.30	405	540	24.0	190
M30V1700		410	530	23.0	200
M30V1600		430	550	22.0	215
M27V1500	0.27	430	550	21.0	230

✪ 高效无取向电工钢 High Efficiency Non-oriented Electrical Steel

牌号 Grade	公称厚度 Nominal width mm	屈服强度 Yeild Strength N/mm^2	抗拉强度 Ultra-Tension Strength N/mm^2	延伸率 Ductility %	硬度 Hardness HV1
M50W600-H	0.50	290	420	36.5	160
M50W470H	0.50	270	400	31.0	150

2.7 涂层 Insulating Coating

涂层种类 Coating types	M11 (默认涂层)	M21
组成 Component	含铬，半有机涂层 Chromium containing , semi organic coating	无铬，半有机涂层 Chromium free, semi organic coating
涂层厚度（μm） Coating thickness	0.7~1.5	0.8~5.0
层间电阻（Ω•mm^2/片） Interlayer resistance （Ω•mm^2/slice）	≥100	≥100
附着性 Adhesive property	A 级或 B 级 Class A or class B	A 级或 B 级 Class A or class B
冲片性 Punching property	优 Excellent	优 Excellent
防锈性 Antirust property	优 Excellent	优 Excellent
耐热性 Heat resisting property	耐 N_2 保护，750℃，2h 退火 Resistant annealing at 750 C, N2 protection, for 2h	耐退火性能一般 Annealing resistance in general

2.8 应用 Application

应用 Appliances		全工艺无取向电工钢 Full-process non-oriented electrical steel				
领域 Field	用途 Purpose	冷轧无取向电工钢 Cold-rolled non-oriented electrical steel			高效电工钢 High efficiency electrical steel	
		230~400	440~470	800~1300	470	600~800
旋转机 Rotary machine	大型电机 Large motor	■				
	中型电机 Medium motor	■	■		■	
	压缩机电机 Compressor motor	■	■	■	■	■
	通用电机 General Motors	■	■	■	■	■
	小型精密电机 Small precision motor	■	■	■	■	
	电动汽车用电机 Motor for electric vehicle	■			■	
静止器 The Immobilizer	高频工作电机 High frequency working motor	■			■	
	小型电源变压器 Miniature power supply transformer	■	■	■	■	■
	仪器用变压器 Instrument use transformer	■				
	电抗器 Reactor	■				
	焊机用变压器 Welding machine use transformer		■	■		■
	电源开关 Power switch	■				
	稳压器 Manostat	■	■	■	■	■
	磁性密封器 Magnetic sealing unit	■	■			
	加速器用电磁铁 Electromagnet for accelerator		■		■	

马钢全工艺无取向电工钢以其优良的性能和品质先后应用于格力、美的、信质电机、黄石东贝、西门子、江西华意、卧龙电气、皖南电机、大中电机、大连东芝、越南东芝等国内外知名品牌制造企业。

The Full-process non-oriented electrical steel of Masteel has been widely used

in domestic and foreign well-known brands enterprises, such as GREE, Midea, Xinzhi Motor, Donper Compressor, Wolong motor, Wannan motor, Dazhong motor, Dalian Toshiba, Vietnam Toshiba and so on.

EI 片电源
Power supply made by EI chip

定子
Stator

驱动电机铁芯
Iron Core of Driven Motor

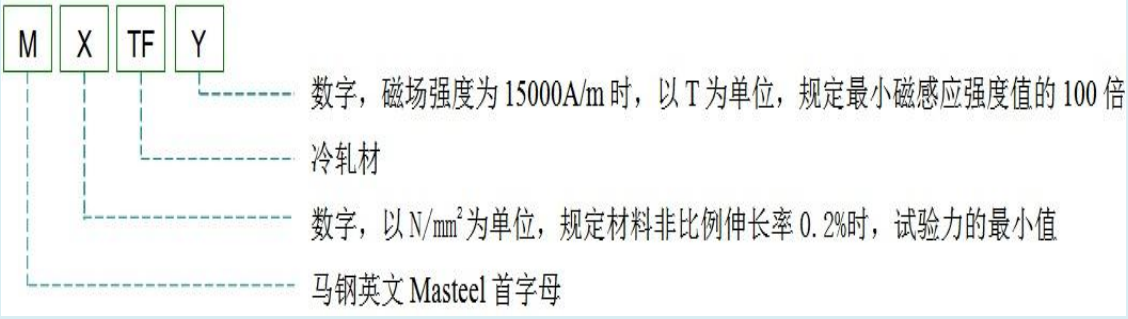
3 冷轧磁极钢 Cold-rolled Magnetic Pole Steel

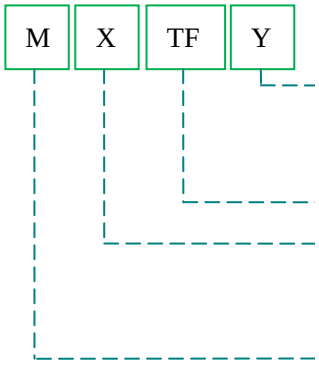
磁极钢是水力发电机等设备制造使用的导磁材料。马钢生产的磁极钢，公称厚度为 0.5mm、1.0mm、1.5mm、1.6mm、1.8mm、2.0mm。产品宽度和厚度也可根据用户需要定制生产。

Magnetic pole steel is a kind of magnetic conductive material used in the manufacture of hydroelectric generator and other equipments. The nominal thickness

of pole steel produced by Masteel is 0.5mm, 1.0mm, 1.5mm, 1.6mm, 1.8mm and 2.0mm. The width and thickness can also be customized according to the user's needs.

3.1 产品牌号的表示方法 Representing method of the magnetic pole steel





Figure, taking t as unit, specify 100 times of the minimum magnetic induction intensity when the magnetic field strength is 15000A/m

Cold rolled material

Figure, taking N/mm^2 as unit, the minimum figure of the experimental force when the non proportional elongation of the material is 0.2%

The initials of Masteel

3.2 产品性能保证值 Guaranteed Properties of Magnetic Pole Steel

牌号 Grade	公称厚度 Normal thickness（mm）	屈服强度 Yield strength (N/mm^2)	抗拉强度 Tensile strength (N/mm^2)	延伸率 Elongation rate（%）	磁感 B_{50} Magnetic induction intensity（T）	磁感 B_{150} Magnetic induction intensity（T）
M250TF183	0.5~2.0	≥250	≥350	≥16	≥1.60	≥1.83
M300TF182		≥300	≥400	≥15	≥1.55	≥1.82
M350TF181		≥350	≥450	≥13	≥1.52	≥1.81
M400TF180		≥400	≥500	≥11	≥1.50	≥1.80
M450TF179		≥450	≥550	≥9	≥1.48	≥1.79
注：测量理论密度：7.85kg/dm^3 Remarks: Theoretical density: 7.85kg/dm^3						

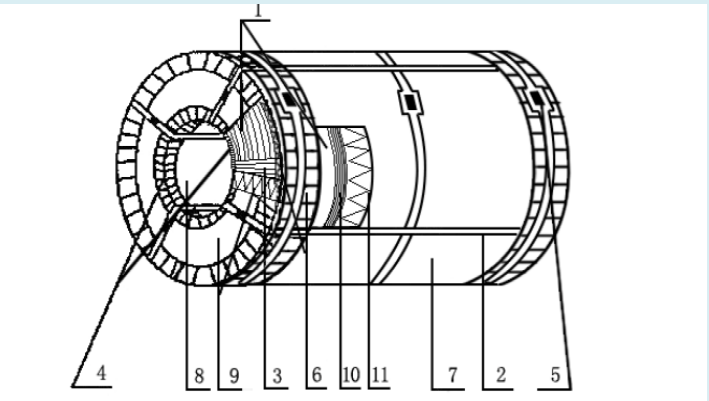
3.3 产品性能典型值 Typical Properties of Magnetic Pole Steel

牌号 Grade	公称厚度 Normal thickness（mm）	屈服强度 Yield strength (N/mm^2)	抗拉强度 Tensile strength (N/mm^2)	延伸率 Elongation rate（%）	磁感 B_{50} Magnetic induction intensity（T）	磁感 B_{150} Magnetic induction intensity（T）
M250TF183	0.5~2.0	280	380	19	1.70	1.92
M300TF182		330	445	25	1.70	1.91
M350TF181		380	480	25	1.67	1.90
M400TF180		420	530	18	1.65	1.89
M450TF179		460	560	10	1.65	1.89
注：测量理论密度：7.85kg/dm^3 Remarks: Theoretical density: 7.85kg/dm^3						

4 包装 Packages

钢带的包装、标志及质量证明书执行马钢企业标准Q/MGB 458规定。如需方对包装有特殊要求，可经供需双方协商，在合同中注明。包装为卧式卷包装。

The relative stipulation of package, mark and quality certification are carried out by the standard of Q/MGB 458 of Masteel. You can note in the contract by negotiation between the buyer and the supplier, if you have special requirements for the packing. And the packing is horizontal steel coil.



1-钢带；2-捆带；3-防锈纸；4-内钢护角及内缓冲护角；5-锁扣及锁扣垫片；6-外钢护角及外缓冲护角；7-外周护板；8-内周护板；9-圆护板及缓冲圆护板；10-塑料膜；11-发泡膜

1. Steel strip
2. Banding strap
3. Rust proof paper
4. Inner angle guard
5. Lock and Shim
6. External corner guard
7. External guard
8. Inner guard
9. Round guard
10. Plastic film
11. Foamed film

主要包装方式

Main packaging methods

5 消除应力退火 Stress Relief Annealing

电工钢在剪切、冲压以及弯曲加工过程中会产生应力，导致磁性能恶化，通常可通过退火消除应力、改善产品性能。用户务必注意以下几点：

Cutting, stamping and bending process will deteriorate magnetic property of the full-process non-oriented electrical steel. Stress relieving annealing can be used to relief stress and improve property. Please pay attention to the following tips:

■ 退火温度及时间 The annealing temperature and time

合理的退火温度范围为 700℃～800℃，保温时间可以根据铁芯的形状、装入量进行适当调整。

The reasonable annealing temperature range is 700 ~ 800℃, and the holding time can be adjusted according to the shape and loading quantity of the iron core.

■ 退火气氛 Annealing atmosphere

必须合理控制炉内气氛，推荐 N_2、Ar 或者 N_2+ H_2。要求炉内气体的露点在较低的状态（DP＜0℃），以保证在退火过程中不降低涂层绝缘性能。

It is necessary to control furnace atmosphere reasonably, and N_2, Ar or N_2+ H_2 is recommended. The dew point of the gas in the furnace is required to be controlled at a lower state (DP < 0℃), so as to ensure the insulation property of the coating is not reduced during the annealing process.