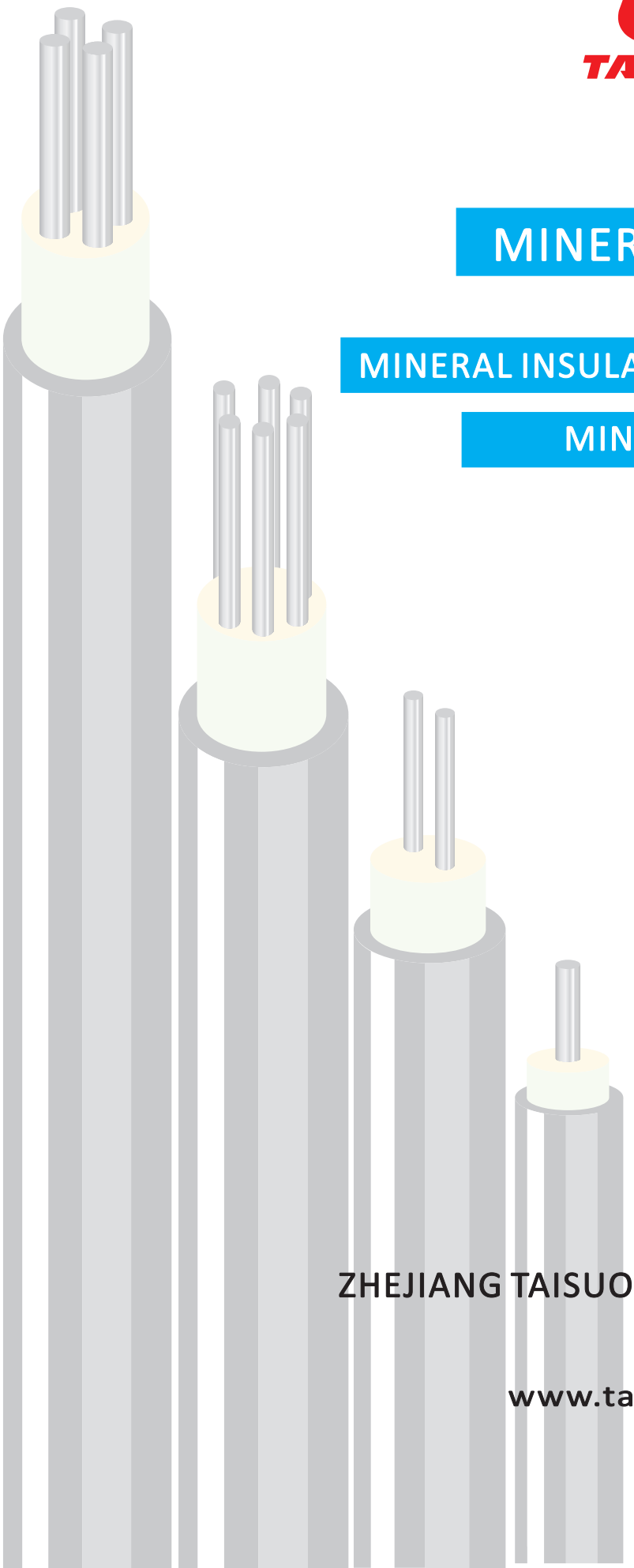
泰索科技
TAISUO TECHNOLOGY

MINERAL INSULATED CABLE

MINERAL INSULATED THERMOCOUPLE CABLE

MINERAL INSULATED RTD CABLE



ZHEJIANG TAISUO TECHNOLOGY CO.,LTD

www.taisuo.com

Version 2017

泰索科技 TAISUO TECHNOLOGY

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Our Products

Mineral Insulated Cable
-- exceptionally durable and long lasting providing unrivalled value

Mineral Insulated Heating Cables
-- can provide stable thermal energy for a long periods of time

Mineral Insulated Communication Cables
-- capable of transmitting signals stably and reliably over extremely long distances at very low/high temperatures

Mineral Insulated Fireproof Cables
-- power can still be safely supplied at higher than 1000℃

Mineral Insulated Thermocouple / Transducer(Rtd) Cables
-- quickly and accurately measure temperature,

OUR AIM: TO SAFELY PROVIDE HEAT, USING STABLE HEAT , PRECISE CONTROL HEAT, TO PROVIDE ONE-STOP SERVICE OF THERMAL MANAGEMENT TO OUR CUSTOMERS

THIS CATALOGUE FOCUSES ON MINERAL INSULATED THERMOCOUPLE CABLES AND MINERAL INSULATED TRANSDUCER(RTD) CABLES

泰索科技 TAISUO TECHNOLOGY

Company History

【2015-2017】Management Transformation Year
Taisuo strengthen cooperation with the domestic and foreign reasearch universities, institution and professional manufactory to slove the technology and management bottlencks in the development of industry, such as sloving the weakness on the core material, developing intelligent equipment, high-performance and technical standard. Providing a thorough grounding in the development on specialization segment market, Taisuo fully enhance the self-regulated, self-enhancement ability and development space, perfect technical and management reserve in the relevate industry chain.

【2014】Consolidate Base Year
In the next decade,we aim to become “Well-known enterprises of Temperature measurement and control and related fields, which is as pur a long-term development concept and goals. We aim at the improvement and integration on upstream and downstream of industry chain, in order to contribute to the sustainable development in our field.

【2013】It was a year of expanding production system and creating the brand public praise. Taisuo's products gained the praise on market in military industry, thermoelectricity, chemical industry, nuclear power, machinery, foodstuff, medicine and other fields.

【2012】 Established Hangzhou Operation center to expand domestic and foreign markets. Ningbo Taisuo Technology Co.,Ltd. was upgraded Zhejiang Taisuo Technology Co.,Ltd.in this year.

【2011】Taisuo passed the ISO: 9001.2008 international quality system certification. Taisuo is assessed as the member of National council of Nuclear Energy Industry Associations.

【2010】300 thousand meters MI Cable exported to foreign market and gained the praise from clients. In this year, the ratio of Class 1 products reached more than 90%. At the same time we began to research mineral insulated fireproof cables, heating cables and other special cable.

【2006-2008】Ningbo Taisuo Technology Co.,LTD is set up,basis on investment in temperature controller field.The first production line of MI Cable which can produce annual output 250 thousand meters, was prepared to construct and gone into operation.

【2004】Basis on existing industry, Taisuo prepared to establish relevant technical design and development on temperature controller field.

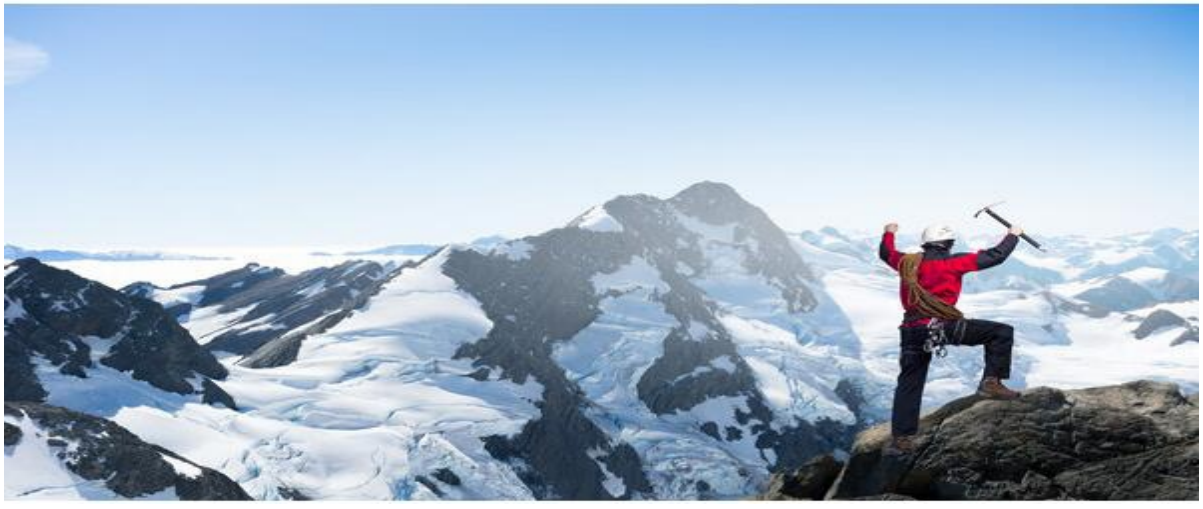
【1999】Introduced advanced temperature instrument automation S M T operating lines and first-class of detection operating system.

【1997】Taisuo grew out of Huatai. And develop rapidly in the following years.

【1995】Taisuo developed the different series of temperature controller.

【1992】Taisuo built the sale department to sell and produce temperature controller.

【1989】Taisuo built the entrepreneurial team to study temperature automation controller.



Since the beginning of time, people have constantly strived to find and endeavoured to utilize various types of energy. Thermal energy is the one from which mankind has derived the greatest benefits in various energy sources.

Since its inception, Zhejiang Taisuo Technology Co., engaged in thermal management system. Nearly 30 years of continuous investing a mass of manpower and resources into research and development the new products, new technique and new equipments. Synchronization with international advanced technology and combined with the own original technology, has become a famous manufacturer of thermal management system products.

With the development of the times, now energy-saving and pollution reduction has become the whole society's concept of environmental protection. Taisuo has always been taking responsibility for more effective utilization of thermal energy. In order to realize energy saving and emission reduction, we are committed to promoting our technologies to more application of thermal management system.

Also, in order to meet the more needs, we are making every effort to acquire expertise and technology in all the fields. Taisuo built a Temperature Laboratory for precise calibration to verify accuracy of thermal management system products.

In fact, Taisuo takes great pride in our quality and Technology. Nevertheless, we are determined to continue our efforts for research and development in the technology of temperature measurement for the new and better products, foreseeing exact needs of human life and industry.

Hangzhou Operating Center

Factory

Certificates

TRADEMARK REGISTRATION CERTIFICATE

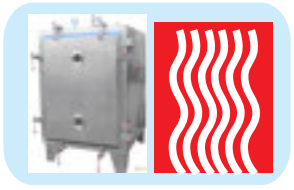
CERTIFICATES OF CE AND RoHS

QUALITY MANAGEMENT SYSTEM CERTIFICATE

A MEMBER OF CHINA NUCLEAR INDUSTRY ASSOCIATION

PATENT CERTIFICATES

DIRECTOR UNIT OF CHINA INSTRUMENT FUNCTIONAL MATERIALS INDUSTRY ASSOCIATION



Requirements and verification tests

Drying And Sealing

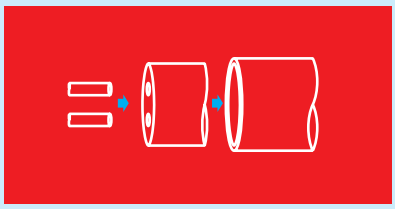
Packaging And Storage

Detection And Calibration

Annealing

Reducing the Diameter

Swaging & Drawing



Assembled Thermocouple Conductor,Mgo and Outer Sheath

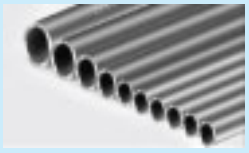
Drying

Straightening

Cleaning

Insulation Material

Wire



Tube

Brief Description of Mineral Insulated Metal-sheathed Cables

Definition

Mineral insulated metal-sheathed cable has an outer sheath of metal with Two to Eight Cores where positive and negative thermoelements run around Circular Pattern , embedded in MgO. Mineral Insulated Cables are suitable to high Mechanical, Chemical, and Electrical stability. Due to good Flexibility, Excellent mechanical strength, and pressureresistance, mineral insulated Thermocouples/RTD's can be installed in complex installations.One or more wire like conductors (cores) are embedded in a high insulation quality MgO and pressed into a metal tube (sheath) made of oxidation and corrosion resistant material. The entire combination is then processed using suitable forming steps to obtain the final dimensions.

Classification

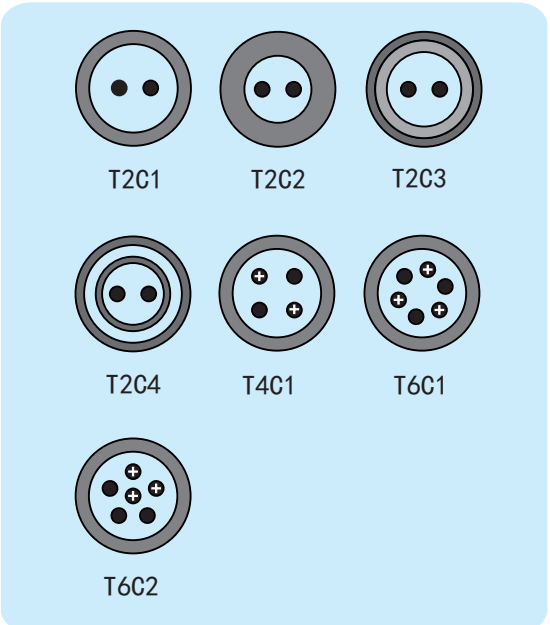
- Mineral insulated thermocouple cables
- Mineral insulated resistance temperature detectors cables
- Mineral insulated fireproof cables
- Mineral insulated heating cables
- Mineral insulated communication cables
- Mineral insulated special cables

Application

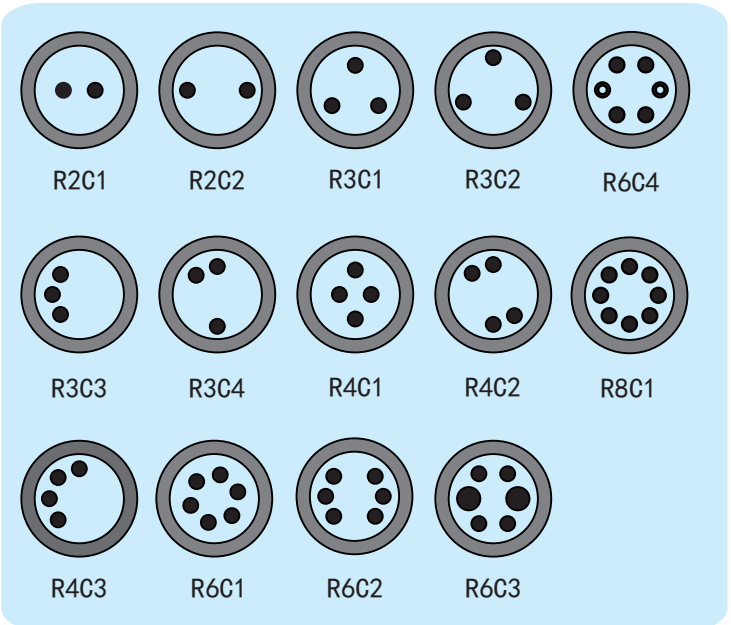
Temperature measurement,Signal transmission and special heating for Chemical, pharmaceutical, Food, metallurgy, machinery manufacturing, Nuclear power, thermal power, scientific experiments and other industries

This catalogue is mainly for mineral insulated thermocouple cables and mineral insulated resistance temperature detectors(RTD) cables

Cross-section of
mineral insulated thermocouple cables



Cross-section of
resistance temperature detectors cables

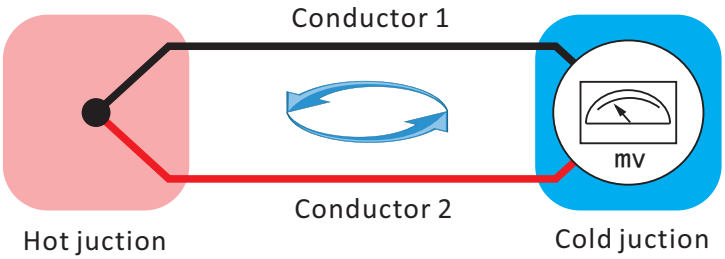


Definition

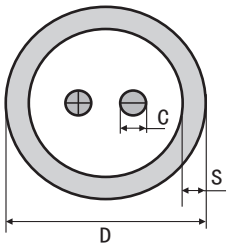
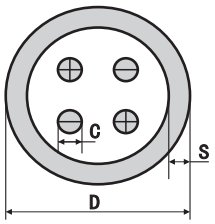
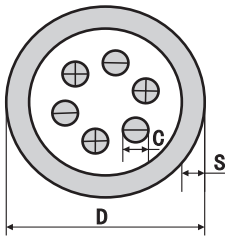
Mineral insulated construction results in thermocouples wires that are surrounded by a compacted mineral insulation(MgO) and contained in a sheath such as stainless steel or heat resisting steel, on the basis of this mineral insulated construction , a wide variety of otherwise difficult applications are possible. Compared with general-purpose (protection tube type)thermocouples, sheathed thermocouples have many advantages, such as pressure resistance , shock resistance, fast thermal responsivity and flexible.

Working principle

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances. Connection temperature display instrument, the instrument will show the thermocouple generated by the thermal potential of the corresponding temperature value.The thermoelectric potential of the mineral insulated thermocouple will increase with the temperature of the measuring end,The size of thermoelectric power is only related to thermocouple conductor material and temperature difference,It has nothing to do with the length and diameter of the thermoelectric pole.



Data of Mineral Insulated Thermocouple Cables

Number of conductors	O.D D (mm)	Tolerance (mm)	Min.conductor Dia. C (mm)	Min.wall Thick. S (mm)	Minimum Insulation resistance		
					Test temperature	Insulation resistance	Test voltages
Simplex 	0.5	±0.025	>0.08	>0.05	20℃±15℃	≥1000MΩ.m	50 to 100VDC
	1.0	±0.025	0.15	0.10	20℃±15℃	≥5000MΩ.m	50 to 100VDC
	1.5	±0.025	0.23	0.15			
	2.0	±0.025	0.30	0.20	20℃±15℃	≥10000MΩ.m	450 to 550VDC
	3.0	±0.030	0.45	0.30			
	3.2	±0.032	0.48	0.32			
	4.0	±0.040	0.60	0.40			
	4.5	±0.045	0.68	0.45			
	4.8	±0.048	0.72	0.48			
	6.0	±0.060	0.90	0.50			
	6.4	±0.064	0.96	0.54			
	8.0	±0.080	1.20	0.80			
	9.5	±0.095	1.43	0.95			
	10.8	±0.108	1.62	1.08			
Duplex 	1.5	±0.025	0.17	0.14	20℃±15℃	≥10000MΩ.m	450 to 550VDC
	2.0	±0.025	0.22	0.18			
	3.0	±0.030	0.33	0.27			
	3.2	±0.032	0.35	0.29			
	4.0	±0.040	0.44	0.36			
	4.5	±0.045	0.50	0.41			
	4.8	±0.048	0.53	0.43			
	6.0	±0.060	0.66	0.54			
	6.4	±0.064	0.70	0.58			
	8.0	±0.080	0.88	0.72			
	9.5	±0.095	1.05	0.86			
	10.8	±0.108	1.19	0.97			
Triplex 	3.2	±0.032	0.29	0.26	20℃±15℃	≥10000MΩ.m	450 to 550VDC
	4.5	±0.045	0.41	0.36			
	4.8	±0.048	0.43	0.38			
	6.4	±0.064	0.58	0.51			
	8.0	±0.080	0.72	0.64			
	10.8	±0.108	0.97	0.86			

【1】We can supply high purity magnesium oxide (≥ 99.4%MgO).

【2】The insulation of a thermocouple cable has finite conductivity and therefore the insulation resistance decreases as the length of the thermocouple cable increases. The conductance of a specific thermocouple cable is therefore expressed in $S \cdot m^{-1}$ (equivalent to $\Omega^{-1} \cdot m^{-1}$) and the minimum specified insulation resistance is expressed in Ω·m, KΩ·m or MΩ·m for thermocouple cables.

【3】Please contact us for more information.

Rough Introduction Of Common Thermocouples

Type	Material		Recommended Temp.Range °F (°C)	Application
K	+	Ni Cr	32–2300°F (0–1260°C)	Recommended for continuous oxidizing or neutral atmospheres. Mostly used above 1000°F (530°C).
	–	Ni Si/Ni Al		
N	+	Ni Cr Si	32–2300°F (0–1260°C)	Can be used in application where Type K elements have shorter life and stability problems due to oxidation and the development of "Green Rot".
	–	Ni Si		
E	+	Ni Cr	32–1600°F (0–871°C)	Recommended for continuous oxidizing or inert atmospheres. Highest thermoelectric output of common calibrations.
	–	Cu Ni		
J	+	Fe	32–1400°F (0–760°C)	Suitable for vacuum, reducing, or inert atmospheres, oxidizing atmospheres with reduced life, iron oxidizes rapidly above 1000°F (538°C) so only heavy gauge wire is recommended for high temperature.
	–	Cu Ni		
T	+	Cu	−300–+700°F (−184–+371°C)	Useable in oxidizing,reducing,or inert atmospheres as well as vacuum.Not subject to corrosion in moist atmospheres. Limits of error published for sub-zero temperature ranges.
	–	Cu Ni		
R	+	PtRh13%	100–2700°F (538–1482°C)	Recommended for high temperature, must be protected with non-metalic protection tube and ceramic insulators. Continued high temperature usages causes grain growth which can lead to mechanical failure. Negative calibration drift caused by rhodium diffusion to pure leg as well as from rhodium volatilization. Type R is used in industry ,type S in the laboratory.
	–	Pt		
S	+	PtRh10%	100–2700°F (538–1482°C)	Recommended for high temperature, must be protected with non-metalic protection tube and ceramic insulators. Continued high temperature usages causes grain growth which can lead to mechanical failure. Negative calibration drift caused by rhodium diffusion to pure leg as well as from rhodium volatilization. Type R is used in industry ,type S in the laboratory.
	–	Pt		
B	+	PtRh 30%	1600–3100°F (871–1705°C)	Similar as R&S but output is lower. Also less susceptible to grain growth and drift.
	–	PtRh 6%		

Applicable thermocouple type	Test temperature (°C)	Minimum insulation resistance		
		0.5<D≤1.6 (Test voltage is 50 Vdc) MΩ.m	1.6<D≤3.2 (Test voltage is 100 Vdc) MΩ.m	3.2<D (Test voltage is 100 Vdc) MΩ.m
T,J,E,K,N	300±15	150	300	1000
J,E,K,N	500±15	7.5	15	30
E,K,N	800±15	0.075	0.15	0.3
K,N	1000±15	–	0.003	0.006

NOTE D denotes thermocouple cable diameter in mm.

Temperature Range Depending of Thermoelectrode Diameter

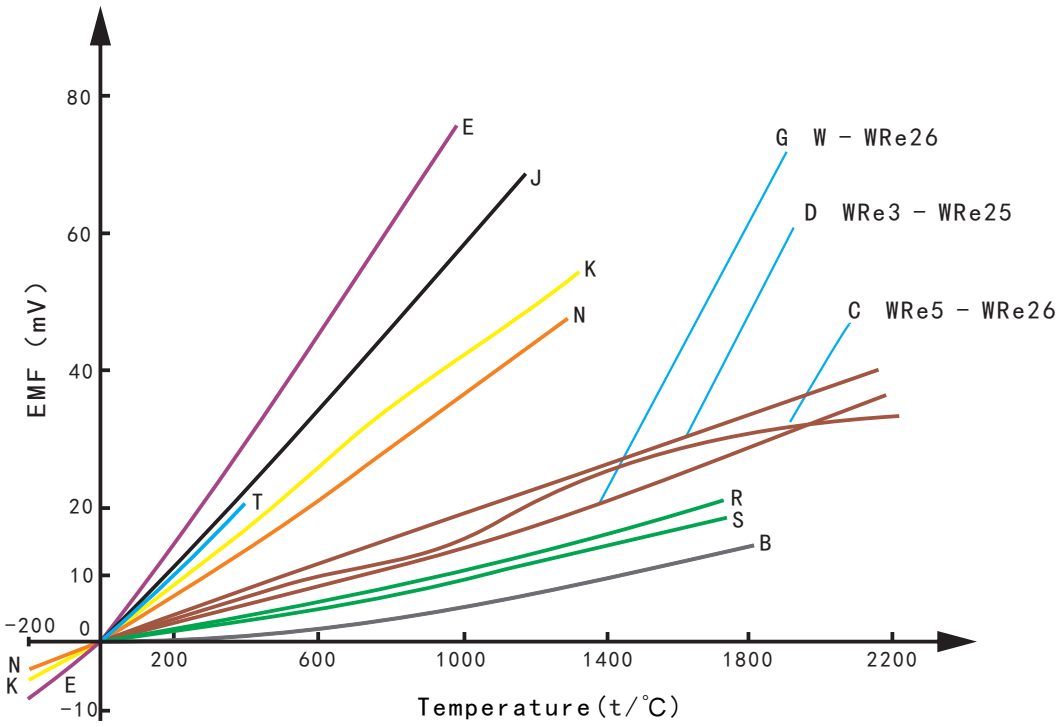
Type	Thermocouple Alloy				EMF at 100℃	O.D. of conductor (mm)	Max operating temperature (℃)	
	Positive		Negative					
	Material	Symbol	Material	Symbol			Normal	Maxima
K	Ni Cr	KP	Ni Si Ni Al	KN	4.096mV	Φ0.3	700	800
						Φ0.5	800	900
						Φ0.8～Φ1.0	900	1000
						Φ1.2～Φ1.6	1000	1100
						Φ2.0～Φ2.5	1100	1200
						Φ3.2	1200	1300
N	NiCr Si	NP	Ni Si	NN	2.774mV	Φ0.3	700	800
						Φ0.5	800	900
						Φ0.8～Φ1.0	900	1000
						Φ1.2～Φ1.6	1000	1100
						Φ2.0～Φ2.5	1100	1200
						Φ3.2	1200	1300
E	Ni Cr	EP	Cu Ni	EN	6.319mV	Φ0.3～Φ0.5	350	450
						Φ0.8～Φ1.2	450	550
						Φ1.6～Φ2.0	550	650
						Φ2.5	650	750
						Φ3.2	750	900
J	Fe	JP	Cu Ni	JN	5.269mV	Φ0.3～Φ0.5	300	400
						Φ0.8～Φ1.2	400	500
						Φ1.6～Φ2.0	500	600
						Φ2.5～Φ3.2	600	750
T	Cu	TP	Cu Ni	TN	4.279mV	Φ0.2～Φ0.3	150	200
						Φ0.5～Φ0.8	200	250
						Φ1.0～Φ1.2	250	300
						Φ1.6～Φ2.0	300	350
R	Pt Rh13	RP	Pt	RN	0.647mV	Φ0.5	1400	1600
S	Pt Rh10	SP	Pt	SN	0.646mV	Φ0.5	1400	1600
B	Pt Rh30	BP	Pt Rh6	BN	0.033mV	Φ0.5	1600	1700

Thermocouple Tolerance and Standard

Thermocouple Type	JIS C1602			IEC584-2		ASTM E230		
	Temperature range (℃)	Class	Error (℃)	Class	Error (℃)	Temperature range (℃)	Class	Error (℃)
K N	−40～375	1	±1.5	1	±1.5	0～1260	STD	±2.2 or ±0.75%·|t|
	375～1000		±0.004·|t|		±0.004·|t|			
	−40～333	2	±2.5	2	±2.5		SP	±1.1 or ±0.4%·|t|
	333～1200		±0.0075·|t|		±0.0075·|t|			
	−167～40	3	±2.5	3	±2.5	−200～0	STD	±2.2 or ±2%·|t|
	−200～−167		±0.015·|t|		±0.015·|t|			
E	−40～375	1	±1.5	1	±1.5	0～870	STD	±1.7 or ±0.5%·|t|
	375～800		±0.004·|t|		±0.004·|t|			
	−40～333	2	±2.5	2	±2.5		SP	±1 or ±0.4%·|t|
	333～900		±0.0075·|t|		±0.0075·|t|			
	−167～40	3	±2.5	3	±2.5	−200～0	STD	±1.7 or ±1%·|t|
	−200～−167		±0.015·|t|		±0.015·|t|			
J	−40～375	1	±1.5	1	±1.5	0～760	STD	±2.2 or ±0.75%·|t|
	375～750		±0.004·|t|		±0.004·|t|			
	−40～333	2	±2.5	2	±2.5		SP	±1.1 or ±0.4%·|t|
	333～750		±0.0075·|t|		±0.0075·|t|			
T	−40～125	1	±0.5	1	±0.5	0～370	STD	±1 or ±0.75%·|t|
	125～350		±0.004·|t|		±0.004·|t|			
	−40～133	2	±1	2	±1		SP	±0.5 or ±0.4%·|t|
	133～350		±0.0075·|t|		±0.0075·|t|			
	−67～40	3	±1	3	±1	−200～0	STD	±1 or ±1.5%·|t|
	−200～−67		±0.015·|t|		±0.015·|t|			
R/S	0～1100	1	±1	1	±1	0～1480	STD	±1.5 or ±0.25%·|t|
	0～600	2	±1.5	2	±1.5		SP	±0.6 or ±0.1%·|t|
	600～1600		±0.0025·|t|		±0.0025·|t|			
B	600～1700	2	±0.0025·|t|	2	±0.0025·|t|	870～1700	STD	±0.5
	600～800	3	±4	3	±4			
	800～1700		±0.005·|t|		±0.005·|t|			

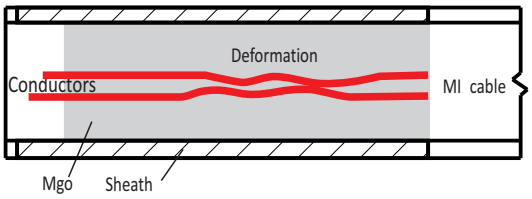
1. Tolerance is referred to as the maximum allowable deviation between hot junction temperature and the temperature derived from the EMF table.
2. ASTM tolerance is ˚C or% value for the measured temperature, whichever is greater.
3. | t | is the measuring temperature indicated by the temperature irrelevant to the symbol + or -.

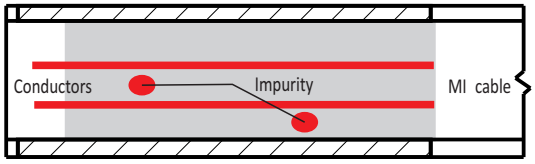
Thermocouple EMF vs Temperature (DIN EN60584 IEC 60584-1)

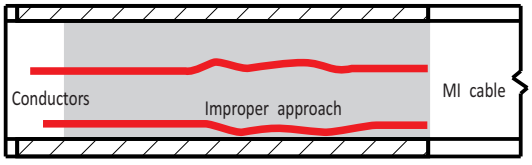


Improper inner structure for MI cable

As shown, the EMF was unsteady for the improper inner structure of MI thermocouple cable; Even its inner structure would go short circuit because of the shock and impact .

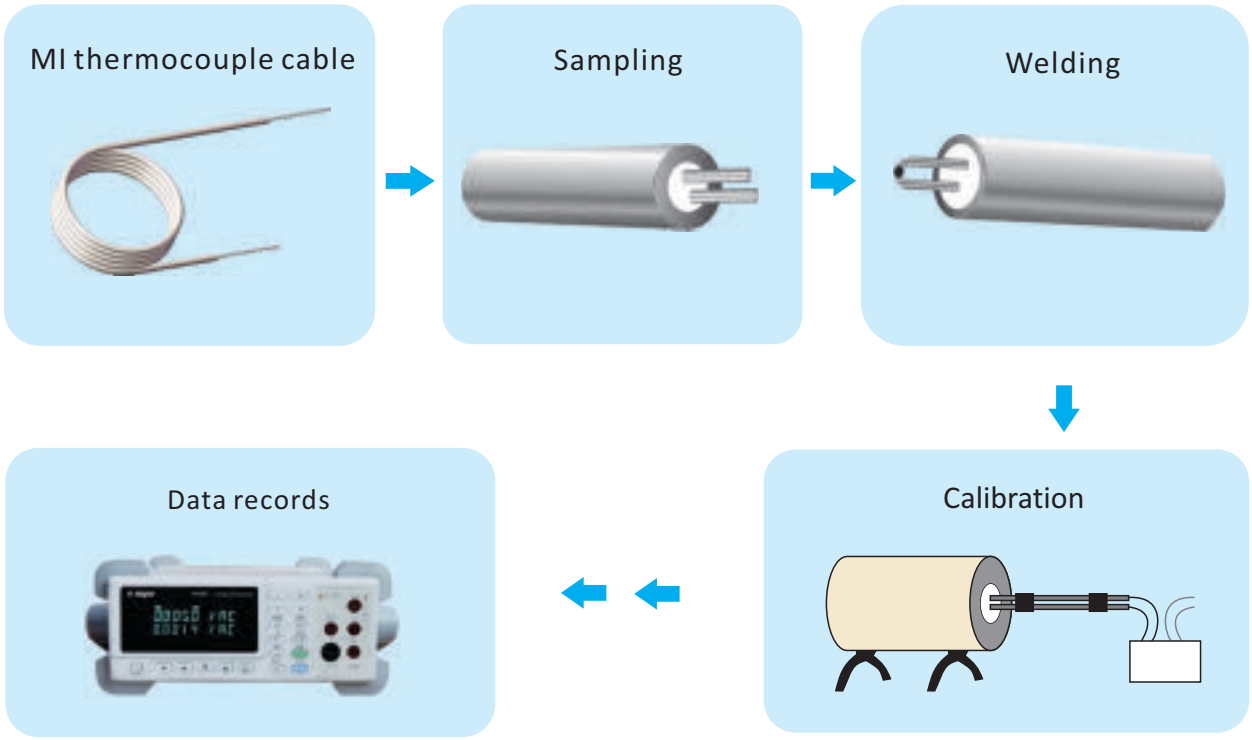






The special advantages of TaiSuo's Mineral Insulation Thermocouple Cable

- Ultra high accuracy
- Ultra long length
- Multiple metal sheath materials
- Customized products
- Ultra long working-life
- High Insulation
- Special configuration



According to the following standards:
IEC 584
IEC 61515
ASTM E230

Order code of Mineral Insulated Thermocouple Cables

MIC	TC	1	2	3	4	5	6
Mineral insulated cable	Thermocouple	Type	Sheath material	O. D.（φ）	Number of conductors	Error class	Cross-section
		K	304	0. 5	2	I	T2C1
		N	321	1. 0	4	II	T2C2
		E	316	1. 5	6	III	T2C3
		J	316L	1. 6			T2C4
		T	310S	2. 0			T4C1
		R	INCONEL600	3. 0			T6C1
		S	446	3. 2			T6C2
		B		4. 0			
				4. 8			
				5. 0			
				6. 0			
				6. 4			
				8. 0			
				9. 5			
				10. 0			
				10. 8			
				12. 7			

Order code example : MIC-TC-N-316-3.0-4-I-T4C1

MI CABLE thermocouple– type (N) – sheath material (SS 316) – sheath diameter（Φ3. 0）– conductors (4) – error class I – configuration (T4C1).

1. The above is common order code, please contact us for more information.
2. please refer to page 16 : Error class and EMF table for thermocouple.
3. 6 means configuration as below; Please refer to page 6 for details.
4. For other sheath materials, please refer to page 19.

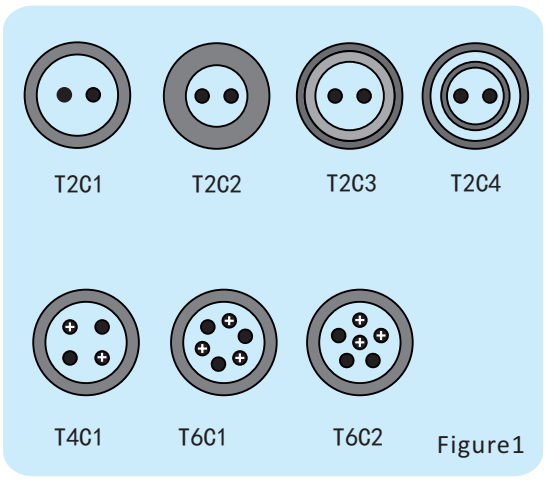


Figure1


Figure2

Operating Temperature Of MI Thermocouple Cables

Type	Sheath material	Sheath Diameter Φ(mm)	Recommended operating temperature (℃)
K	304/304L/316/316L/321	0.5~1.0	700
		1.5~8.0	800
	310/310L	0.5~1.0	700
		1.5~2.0	920
		3.0~8.0	1050
	INCONEL600	0.5~1.0	700
		1.5~2.0	920
		3.0	1070
		4.5~8.0	1150
N	304/304L/316/316L/321	0.5~1.0	700
		1.5~8.0	800
	310/310L	0.5~1.0	700
		1.5~2.0	920
		3.0~8.0	1050
	INCONEL600	0.5~1.0	700
		1.5~2.0	920
		3.0	1070
		4.5~8.0	1150
E	304/304L/316/316L/321	0.5~1.0	300
		1.5~2.0	510
		3.0	650
		4.5	730
		6.0~8.0	800
	310/310L	0.5~1.0	300
		1.5~2.0	510
		3.0	650
		4.5	730
		6.0~8.0	820
	INCONEL600	0.5~1.0	300
		1.5~2.0	510
		3.0	650
		4.5	730
		6.0~8.0	820
J	304/304L/316/316L/321	0.5~1.0	260
		1.5~2.0	440
		3.0	520
		4.5	620
		6.0~8.0	720
	310/310L	0.5~1.0	260
		1.5~2.0	440
		3.0	520
		4.5	620
		6.0~8.0	720
	INCONEL600	0.5~1.0	260
		1.5~2.0	440
		3.0	520
		4.5	620
		6.0~8.0	720
T	304/304L/316/316L/321	0.5~2.0	260
		3.0	315
		4.5~8.0	370
	310/310L	0.5~2.0	260
		3.0	315
		4.5~8.0	370
	INCONEL600	0.5~2.0	260
		3.0	315
		4.5~8.0	370

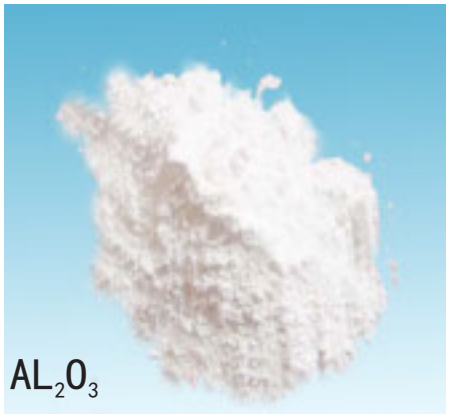
Note: The service life and temperature range of the MI thermocouple cable is effected by measurement medium and operating condition. The above data is for your reference.

Error Class And EMF for Thermocouple

Type		"T" Cu-CuNi	"J" Fe-Cu	"E" NiCr-CuNi	"K" NiCr-NiSi	"N" NicrSi-NiSi	"S" PtRh10%-Pt	"R" PtRh13%-Pt	"B" PtRh30%-PtRh6%
Calibration		IS2056/ ASTM E230	IS2056/ ASTM E230	ASTM E230	IS2054/ ASTM E230	ASTM E230	IS2055/ ASTM E230	IS2055	IS6720
Tolerences	Standard	±1℃ or ±0. 75%	±2. 2℃ or ±0. 75%	±1. 7℃ or±0. 5%	±2. 2℃ or ±0. 75%	±2. 2℃ or ±0. 75%	±1. 5℃ or ±0. 25%	±1. 5℃ or ±0. 275%	±1. 5℃
	Special	±0. 5℃ or ±0. 4%	±1. 1℃ or ±0. 4%	±1℃ or ±0. 4%	±1. 1 or ±0. 4%	±1. 1℃ or ±0. 4%	±0. 6℃ or ±0. 1%	±0. 6℃ or ±0. 1%	OVER800℃
Temperature ℃	-100	−3. 379	−4. 633	−5. 232	−3. 554	−2. 407	–	–	–
	0	0	0	0	0	0	0	0	0
	100	4. 279	5. 269	6. 319	4. 096	2. 774	0. 646	0. 647	0. 033
	200	9. 288	10. 799	13. 421	8. 138	5. 913	1. 441	1. 469	0. 178
	300	14. 862	16. 327	21. 036	12. 209	9. 314	2. 323	2. 401	0. 431
	400	20. 872	21. 848	28. 946	16. 397	12. 974	3. 259	3. 408	0. 787
	500	–	27. 393	37. 005	20. 644	16. 748	4. 233	4. 471	1. 242
	600	–	33. 102	45. 093	24. 905	20. 613	5. 239	5. 583	2. 431
	700	–	39. 132	53. 112	29. 129	24. 527	6. 275	6. 743	3. 154
	800	–	45. 494	61. 017	33. 275	28. 455	7. 345	7. 950	3. 957
	900	–	–	68. 787	37. 326	32. 371	8. 449	9. 205	4. 834
	1000	–	–	76. 373	41. 276	36. 256	9. 587	10. 506	5. 78
	1100	–	–	–	45. 119	40. 087	10. 757	11. 850	6. 786
	1200	–	–	–	48. 383	43. 846	11. 951	13. 228	7. 311
	1250	–	–	–	50. 644	45. 694	12. 554	13. 926	7. 848
	1300	–	–	–	52. 410	47. 513	13. 159	14. 629	8. 956
	1400	–	–	–	–	–	14. 373	16. 040	10. 099
	1500	–	–	–	–	–	15. 582	17. 451	11. 263
	1600	–	–	–	–	–	–	–	12. 433

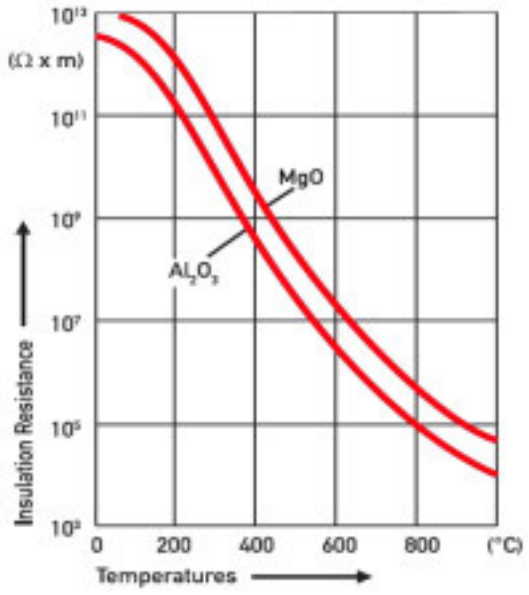


Magnesium Oxide, white powder, odorless, tasteless and non-toxic, can slowly absorb carbon dioxide in the air. Formula is MgO , Melting point: 2852°C, Boiling Point: 3600°C, Density: 3. 58g/cm^3 (25°C) .



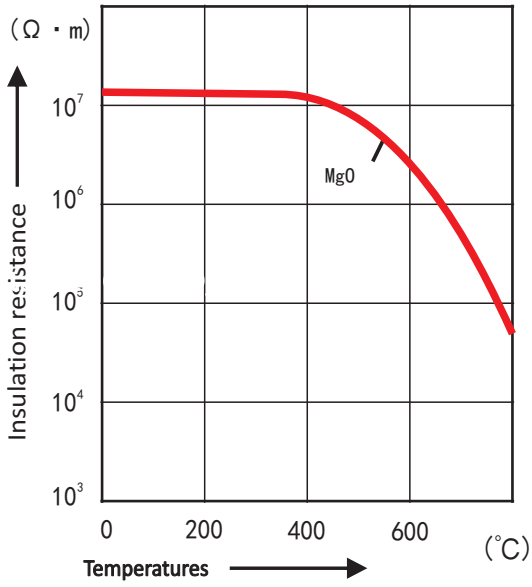
Aluminum oxide, formula is AL_2O_3, is a kind of high hardness compound, melting point :2054°C, boiling point : 2980°C, white solid insoluble, odorless, tasteless, hard texture, easy moisture absorption and non-deliquescent (no hygroscopic in burning).

Insulation resistance of MgO & AL_2O_3 under different temperature



DC Voltage
Insulation resistance of cables measured with 20VDC

Insulation resistance of MgO under different temperature



AC Voltage
Insulation resistance of cables measured with 500V-AC50Hz.

Physical Properties & Typical Chemical Composition of Insulation Materials

physical properties	Unit	MgO	Al_2O_3
Density (crystal)	g/cm^3	3.65	3.98
Density in MIC	g/cm^3	3	2.9
Melting point	℃	2800	3000
Specific Heat (20–300℃)	J/gK	1.03	0.95
Coefficient of Exp. (20–200℃)	$10^{-6}/K$	11.3	6.55
Coefficient of Exp. (20–600℃)	$10^{-6}/K$	13.2	7.62
Resistivity 20℃	Ω · m	5×10^{16}	1×10^{14}
Resistivity 400℃	Ω · m	1×10^{13}	1×10^{12}
Resistivity 800℃	Ω · m	5×10^{8}	2×10^{8}
Dielectric Constant 20℃	–	5	9
Knoop Hardness	N/mm^2	3700	21000
Modulus of Elasticity 20℃	N/mm^2	3×10^{5}	3.6×10^{5}

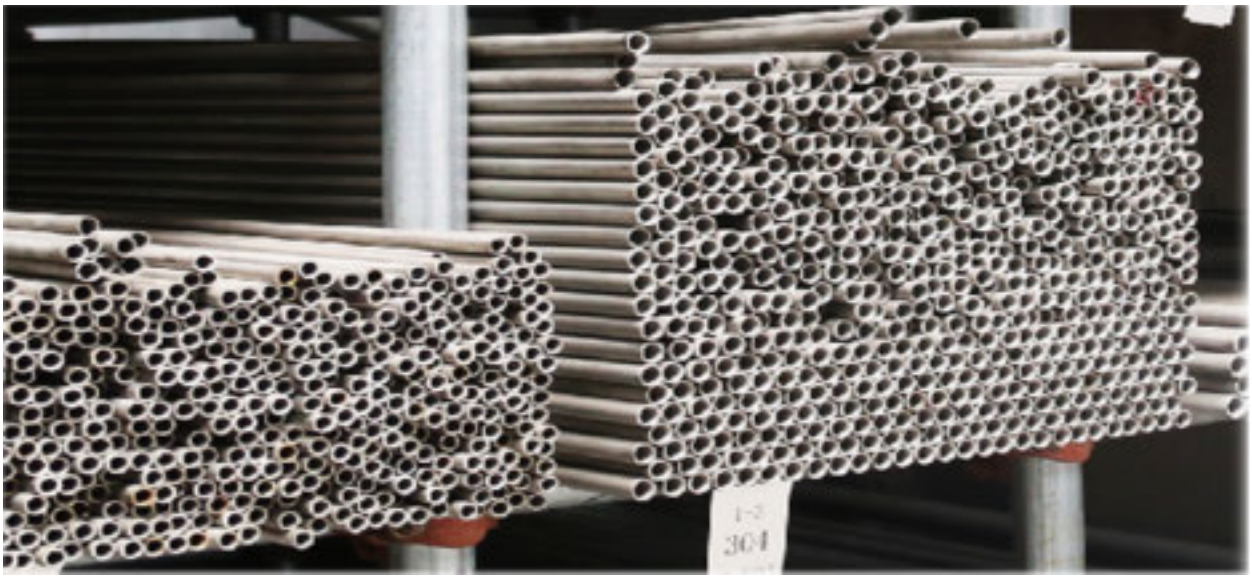
Typical composition of insulation materials MgO/Al_2O_3

Composition	MgO(97%)	MgO(99.4%)	Al_2O_3
MgO	≥98.0	≥99.715	0.08
Al_2O_3	0.4	0.05	99.8
CaO	0.35	0.198	0.004
Fe_2O_3	0.15	0.051	0.009
SiO_2	0.35	0.026	0.08
B&Cd	<10 ppm	<1 ppm	<10 ppm

Material Designation For Sheath Materials of MI Thermocouple Cable

NO	GERMANY		USA	BS	FRANCE	JAPAN	CHINA
	WNR	DIN	AISI	BS	AFNOR	JIS	GB
1	1.4301	X5CrNi18-9	304	304S	Z6CN18-09	SUS304	06Cr19Ni10
2	1.4306	X5CrNi19-11	304L	304S	Z2CN18-10	SUS304L	022Cr19Ni10
3	1.4401	X5CrNiMo18-10	316	316S	Z6CND17-11	SUS316	06Cr17Ni12Mo2
4	1.4404	X2CrNiMo18-10	316L	316S	Z2CND17-12	SUS316L	022Cr17Ni12Mo2
5	1.4541	X6CrNiTi18-10	321	321S	Z6CNT18-11	SUS321	06Cr18Ni11Ti
6	1.4550	X6CrNiNb18-10	-	347S	Z6CNNb18-11	SUS347	06Cr18Ni11Nb
7	1.4571	X6CrNiMoTi17-12-2	316Ti	320S31	Z6CNDT17-12	SUS316Ti	06Cr17Ni12Mo3Ti
8	1.4845	X12CrNi25-21	310S	310S	Z12CN25-20	SUS310S	06Cr25Ni20
9	2.4816	Alloy600	INC600	-	NC15Fe	NCF600	NS3102
10	2.4851	Alloy601	INC601	-	-	NCF601	NS313
11	1.4876	Alloy800	INC800	NA15	Z10NG32-21	NCF800	NS1101
12	2.4858	Alloy825	INC825	NA16	NFe32C20DU	NCF825	Ns142

Note: Please contact us for more information.



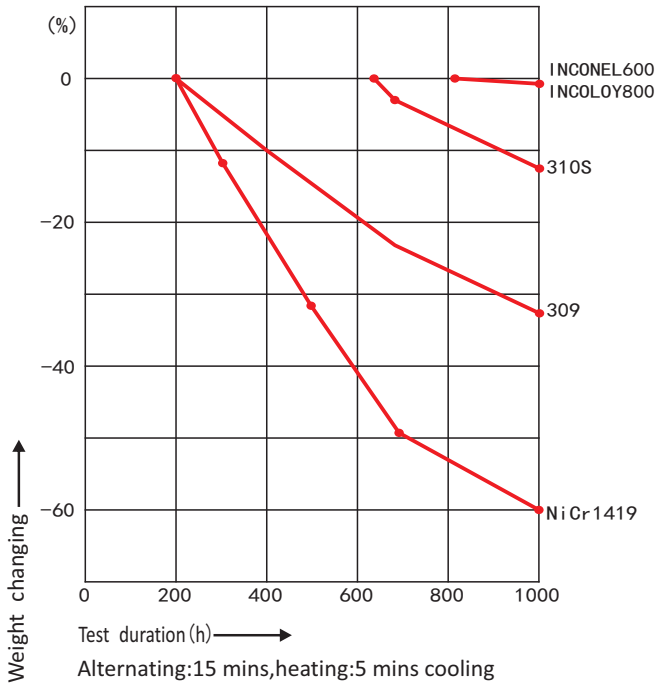
Outer Sheath Features Of Mineral Insulated Cables

Material	Working environment	Max operating temperature
304	Oxidizing/Reducing/Neutral/Vacuum	930℃
321	Oxidizing/Reducing/Neutral/Vacuum	930℃
316/316L	Oxidizing/Reducing/Neutral/Vacuum	980℃
310S	Oxidizing/Reducing/Neutral/Vacuum	1100℃
446	Oxidizing/Reducing/Neutral/Vacuum	1100℃
INCONEL600	Oxidizing/Reducing/Neutral	1150℃

The Loss In Weight Of Different Sheath Materials In Burning Test

Different sheath materials were heated in air in a cycle as follows:15 mins up to 980℃ (indirect heating), 5 mins cooling to room temperature, 15 mins up to 980℃ and so on.

The diagram below shows the loss in weight (in %) of the specimen versus the test duration (in hours) as a result of the flaking layers of oxide.



Alternating:15 mins,heating:5 mins cooling

It is clear that the scaling resistance of the alloys increases with the sum of nickel and chromium, at 980°C with temperature variation it is excellent in INCONEL 600 (2,4816) and still good in 1.4841. On the other hand 18-9 steels are not suitable for applications at this temperature.

Chemical Composition Of Common Sheath Material

No.	Sheath Material	Composition weighting (%)							
		C	Si	Mn	P	S	Ni	Cr	Others
1	SUS321	≤0.12	≤1.00	≤2.00	≤0.035	≤0.03	8～10	17～19	Ti:[5X(C-0.02)]～0.80
	ASTM321	≤0.08	≤1.00	≤2.00	≤0.035	≤0.03	9～12	17～19	Ti≥5XC
2	ASTM304	≤0.07	≤1.00	≤2.00	≤0.035	≤0.03	8～11	17～19	-
	ASTM304L	≤0.03	≤1.00	≤2.00	≤0.035	≤0.03	8～12	18～20	-
3	ASTM316	≤0.08	≤1.00	≤2.00	≤0.045	≤0.03	10～14	6～18	Mo:2～3
	ASTM316L	≤0.03	≤1.00	≤2.00	≤0.045	≤0.03	10～14	6～18	Mo:2～3
	ASTM316Ti	≤0.08	≤1.00	≤2.00	≤0.045	≤0.03	11～14	6～18	Mo:2～3 Ti:（5XC）～0.70
4	ASTM310S	≤0.08	≤1.00	≤2.00	≤0.045	≤0.03	19～22	24～26	-
5	INCONEL600	≤0.15	≤0.50	≤1.00	≤0.03	≤0.15	>72	14～17	Fe:6～10 Cu:<0

Chemical Composition Of Special Sheath Material

Copper sheath material

Material	Composition weighting (%)	
	Cu+Ag	P
T_{P2}	99.9	0.015～0.040

Aluminum sheath material

Material	Composition weighting (%)								
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Al
6061(Al-alloy)	0.4～0.8	0.7	0.15～0.4	0.15	0.8～0.12	0.04～0.35	0.25	0.15	-

Note: Please contact us for more information.

（Aluminum sheath）

(Copper sheath)

（SS/nickel base alloy sheath)

Table 1: Length of MIMS cable (K/N/E/J/T)

Calibtation	O.D.(mm)	Normal sheath(m)	Special Sheath (m)
K/N/E/J/T	0.5	On request	On request
	1.0		
	1.5		
	1.6		
	2.0	400	–
	3.0	230	3000
	3.2	200	2500
	4.0	130	1600
	4.8	85	1100
	5.0	80	1000
	6.0	60	700
	6.4	50	600
	8.0	30	400
	12.7	11	140

Note: Please refer to our sales for special request .

Table 2: Properties of MIMS cable (S/R/B)

Outer sheath data (mm)		Min. conductor diameter(mm)	Sheath material	Length
Outer Diameter(ϕ)	Min. wall thick.(mm)	S/R/B		
3.0	0.30	0.30	INCONEL600 INCONEL625	On request
3.2	0.32	0.30		
4.0	0.40	0.40		
4.8	0.48	0.45		
5.0	0.50	0.45		
6.0	0.60	0.45		
6.4	0.64	0.45		
8.0	0.80	0.45		

Note: Please refer to our sales for special request.

Definition

Its processing is special, that is : two layers of metal sheath is drawn and becomes relatively small diameter, in the meanwhile, the gap between sheath becomes the smallest. In high temperature (≤ 1280 ℃), this material has excellent stability. After it was made into the temperature sensor, it can replace platinum and rhodium thermocouple in some occasaions .

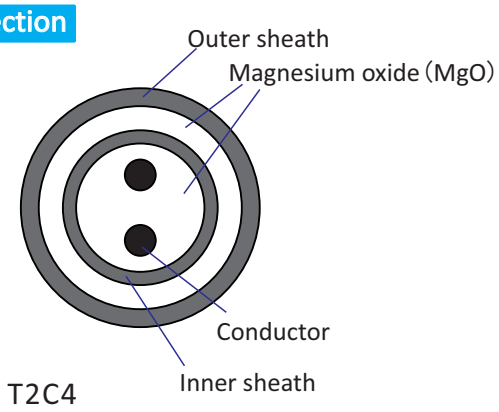
Double-layer mineral Insulated thermocouple cable has good properties, such as high temperature resistance, oxidation resistance and long service life; even in the 1100℃ high temperature and hydrogen （H2) of the reducing gas, it can work normally.

Dimensions and operating temperature data

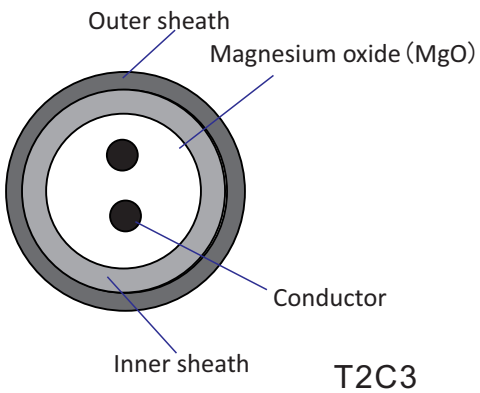
Outer diameter Φ（mm）	4.8/5.0	6.0/6.4	8.0	10.0	12.0	12.7	16.0
Wire Φ（mm）	0.7	1.1	1.1	1.0	2.0	2.4	2.5
Wall thickness of double layer （mm）	0.9	1.4	1.4	2.2	2.2	2.2	2.3
Max. operating temperture for long term（℃）	1100				1150		
Max. operating temperture for short term（℃）	1250				1250		

Note: The above data is just for reference.

Cross- section



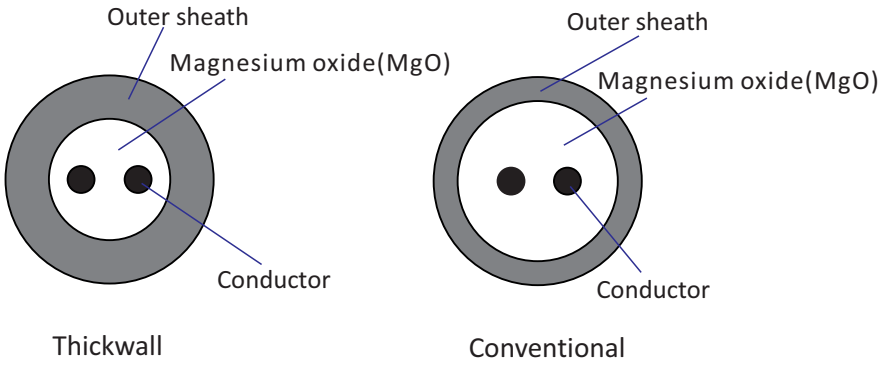
T2C4



T2C3

Sectional Draff Of Double Sheath MI Thermocouple

Comparison of Sectional configuration



Definition

The conventional thermocouple is used with an outer protecting tube or thermowell to protect it from aggressive and corrosive process condition.This improves longevity of the thermocouple.However,response time is poor. To overcome above problem,we have designed MI Thickwall Thermocouple having thicker wall with relatively larger conductor diameters.This construction enable the user to insert the thermocouple directly in the process without a protecting tube or thermowell,improving response time considerably.Its normal applications are Furnaces,rotary kilns,recuperators.

Its normal sheath material is available in SS316/SS310/INCONEL600/ INCONEL800/SS446/GH2747.

Properties

- Faster response
- Long lengths can be offered
- Pliable and easily routed
- Available in SS316,SS310,Inconel 600,Inconel800

Dimensions and operating temperature data

Diameter (mm)	Φ5	Φ6/Φ6.4	Φ8	Φ10	Φ12	Φ12.7	Φ16
Min. Dia. of Wire (mm)	Φ0.7	Φ1.1	Φ1.1	Φ1.4	Φ2.0	Φ2.4	Φ2.5
Wall thickness (mm)	0.88	1.1	1.4	1.9	2.1	2.1	2.3
Max. operating temp.for long term (℃)	1100				1150		
Max. operating temp.forshort term (℃)	1250				1250		

Defination

MI RTD(resistance temperature detector) Cable construction results in pure nickel wire or pure copper that are surrounded by a compacted mineral insulation(Mgo) and contained in a sheath such as stainless steel or heat resisting steel, on the basis of this mineral insulated construction , a wide variety of otherwise difficult applications are possible.

Order code

MIC	RTD	1	2	3	4	5	6
Mineral insulated cable	Mineral Insulated RTD Cable Series	Conductor	Sheath material	Outer Dia.（ϕ）	NO. of conductors	Cross	Note
		Ni	304	2.0	2	R2C1	
		Cu	321	2.5	3	R2C2	
		Ag	316	3.0	4	R3C1	
		Others	316L	3.2	6	R3C2	
			310S	4.0	8	R3C3	
			INCONEL600	4.8		R3C4	
			TP2	5.0		R4C1	
				6.0		R4C2	
				6.4		R4C3	
				8.0		R6C1	
				9.5		R6C2	
				10.0		R6C3	
				12.7		R6C4	
						R8C1	

Order code example:MIC-RTD-Cu-304-3.0-4-R4C1

MI Cable-RTD -conductor material（Cu）-Outer sheath material（304）-Outer diameter （Φ 3.0）－number of conductor （4 cores）－Cross section（R4C1）.

Note:

1、The above is common order code, please refer to our sales for other information.

2、 5 Means cross section ; Please refer to page 6 for details.

Sheath Material And Operating Temperature

Sheath material	Max.operating temperature (℃)	Melting point (℃)	Standard sheath dimensions Φ (mm)
TP2(Copper)	350	1080	On request
304	930	1400	2.0 2.5 3.0 3.2 4.0 4.8 5.0 6.0 6.4 8.0 9.5 10.0 12.7
321	930	1350	
316	980	1370	
INCONEL600	1100	1345	

Dimension/Cross Section Of Mineral Insulated RTD Cables

Outer Dia. Φ (mm)	Wall thick. (mm)	Conductor Dia. (mm) Ni/Cu	Purity of MgO	Sheath Material	Common length (m)	Special length (m)
2.5±0.025	≥0.25	≥0.32	≥96%	304 321 316 316L 310S INC600 Tp_2	320	≥700
3.0±0.030	≥0.30	≥0.4			230	≥500
3.2±0.032	≥0.32	≥0.4			200	≥400
4.0±0.040	≥0.40	≥0.53			130	≥300
4.8±0.048	≥0.48	≥0.64			85	≥200
5.0±0.050	≥0.50	≥0.67			80	≥200
6.0±0.060	≥0.60	≥0.8			60	≥150
6.4±0.064	≥0.64	≥0.85			50	≥150
8.0±0.080	≥0.80	≥1.06			30	≥150
12.7±0.127	≥1.27	≥1.69			10	≥80

Note:1.Please contact us for more information.

Spacing Of Conductors

Table 1: Standard Spaced

Qty Of Conductor	Diameter Of Outer Sheath(D) 1.0	1.5	2.0	3.0	3.2	4.5	6.0	8.0	Inner Circle Diameter (d)
2	X	X	X	(d) 0.9	(d) 1.0	(d) 1.5	(d) 2.0	(d) 2.7	
3	X	X	X						
4	X	X	X						
6	X	X	X						
8	Not available								

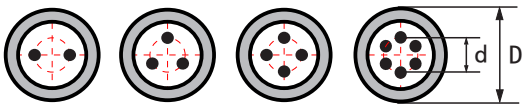
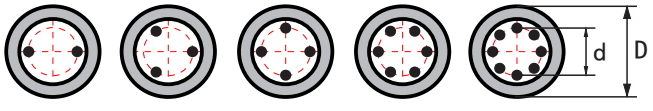


Table 2: Wide Spaced

Qty Of Conductor	Diameter Of Outer Sheath (D) 1.0	1.5	2.0	3.0	4.0	4.5	6.0	8.0	Inner Circle Diameter (d)
2	X	X	X	X	(d) 2.12	(d) 2.38	(d) 3.18	(d) 4.24	
3	X	X	X	X					
4	X	X	X	X					
6	X	X	X	X	X	X			
8	X	X	X	X	X	X			



CHINA GB1220-2007	Japan JIS	USA AISI UNS	BS Bs970 part4 Bs1449 Part2	GERMANY DIN17440 DIN17224	France NFA35-527 NFA35-576～582 NFA35-584
0Cr13	SUS410S	S41000		X7Cr13	Z6C13
1Cr13	SUS410	410	410S21	X10Cr13	Z12Cr13
2Cr13	SUS420J1	420	420S29	X20Cr13	Z20Cr13
		S4200	420S27		
3Cr13	SUS429J2		420S45		
3Cr16	SUS429J1				
1Cr17Ni2	SUS431	431	431S29	X22CrNi17	Z15CN-02
7Cr17	SUS440A	440A			
		S44002			
11Cr17	SUS440C	440C			
		S44004			
8Cr17	SUS440B	44013			
		S44003			
0Cr15Ni7Mo2Al		632			
00Cr12	SUS410				
0Cr13Al[00Cr13Al]	SUS405	405			
		S40500	405S17	X7CrAl13	Z6CA13
1Cr15	SUS429	429			
1Cr17	SUS430	430			
		S43000	430S15	X8Cr17	Z8C17
[Y1Cr17]	SUS430F	430F			
		S43020		X12CrMoS17	Z10CF17
		S43400	434S19	X6CrMo17	Z8cd17.01
1Cr17Ni7	SUA301	301			
		S30100	301S21	X12CrNi177	Z12CN17.07
1Cr17Ni8	SUS301J1			X12CrNi177	
1Cr17Ni9	SUS302	302	302S25	X12CrNi188	Z10CN18.09
1Cr18Ni9Si3	SUS302B	302B			
Y1Cr18Ni9	SUS303	303	303S21	X12CrNiS188	Z10CNFS18.09
Y1Cr18Ni9Se	SUS303Se	303Se	303S41		
0Cr18Ni9	SUS304	304	304S15	X2CrNi89[1.4301]	Z6CN18.09
		S30400			
00Cr19Ni10	SUS304L	304L	304S12	X2CrNi189[1.4306]	Z2CN18.09
		S30403			
0Cr19Ni9N	SUS304N1	304N			Z5CN18.09A2
		S30451			
00Cr19Ni10NbN	SUS304N	XM21			
		S30452			
00Cr18Ni10N	SUS304LN			X2CrNiN1810	Z2CN18.10N
1Cr18Ni12	SUS305	S30500	305S19	X5CrNi911	Z8CN18.12
[0Cr20Ni10]	SUS308	308			
0Cr23Ni13	SUS309S	309S			
0Cr25Ni20	SUS310S	310S			
0Cr17Ni12Mo2	SUS316	316	316S16	X5CrNiMo1812[1.4436]	Z6CND17.12
00Cr17Ni14Mo2	SUS316L	316L	316S12	X2CrNiMo1812[1.4435][1.4404]	Z2CND17.12
0Cr17Ni12Mo2N	SUS316N	316N			
00Cr17Ni13Mo2N	SUS316LN			X2CrNiMoN1812[1.4429]	Z2CND17.12N
0Cr18Ni12Mo2Ti			320S17	X10CrNiMo1810	Z6CND17.12
0Cr18Ni14Mo2Cu2	SUS316J1				
00Cr18Ni14Mo2Cu2	SUS316J1L				
0Cr18Ni10Ti	SUS321	321, S32100	321S12, 321S20	X10CrNiTi189	Z6CNT18.10
1Cr18Ni12Mo3Ti					
0Cr19Ni13Mo3	SUS317	317	317S16		

Tables B.1 and B.2 show typical chemical composition of insulation material for MI thermocouple cables and MI RTD Cables.

Table B.1 - Chemical Composition In Weight Percent Of Recommended Magnesia (MgO)

Purity grade (minimum purity of magnesia)	Maximum impurity contents %							
	SiO_2	CaO	Al_2O_3	Fe_2O_3	B	Cd	S	C
Standard purity（96%）	3.50	1.50	4.00	0.15	0.005	0.001	0.0025	0.020
Medium purity (97.0%)	1.20	0.80	1.00	0.10	0.005	0.001	0.0025	0.020
High purity (99.4%)	0.13	0.35	0.15	0.10	0.0025	0.001	0.0025	0.020

Table B.2 - Chemical Composition In Weight Percent Of Recommended Alumina (Al_2O_3)

Purity grade (minimum purity of alumina)	Maximum impurity contents %									
	SiO_2	CaO	MgO	Fe_2O_3	ZrO_2	B	Cd	Na_2O	S	C
High purity (96%)	0.10	0.08	0.08	0.10	0.080	0.001	0.001	0.06	0.005	0.01

	Metric / Imperial Conversion Formula	Example
1	1feet = 0 . 3 0 4 8m	1 0 0 feet×0 . 3 0 4 8 = 3 0 . 4 8 m
2	1 inch= 2.54 c m	1 0 0 i nch×2 . 5 4 = 2 5 4 c m

	Temperature Unit Conversion Formula	Example
1	°F=（180/100×°C）+32	75°C=（180/100×75）+32=167°F
2	°C=100/180×（°F−32）	212°F=100/180×(212−32)=100°C
3	Fa（° R）=°F+460	40°F=40+460=500Fa（° R）
4	K=°C+273	−10°C=−10+273=263K

SHEATH MATERITL	MAX. OPERATING TEMP.		MATERIAL PROPERTIES
300 SERIES AUSTENITIC CHROMIUM NICKEL ALLOYS	304	900	SS304--the most common grade; the classic 18/8 (18% chromium, 8% nickel) stainless steel. SS304L--same as the 304 grade but lower carbon content to increase weldability. Is slightly weaker than 304.
	321	900	Similar to 304 but lower risk of weld decay due to addition of titanium.
	316	900	the second most common grade (after 304); for food and surgical stainless steel uses; alloy addition of molybdenum prevents specific forms of corrosion. It is also known as marine grade stainless steel due to its increased resistance to chloride corrosion compared to type 304. 316 is often used for building nuclear reprocessing plants.
	316L	930	is an extra low carbon grade of 316, generally used in stainless steel watches and marine applications, as well exclusively in the fabrication of reactor pressure vessels for boiling water reactors, due to its high resistance to corrosion. .
	310S	150	is a highly alloyed austenitic stainless steel used for high temperature application. The high chromium and nickel content give the steel excellent oxidation resistance as well as high strength at high temperature. This grade is also very ductile, and has good weldability enabling its widespread usage in many applications.
400 SERIES FERRITIC AND MARTENSITIC CHROMIUM ALLOYS	446	1090	For elevated temperature a service higher grade of cutlery steel, with more carbon, allowing for much better edge retention when properly heat-treated. It can be hardened to approximately Rockwell 58 hardness, making it one of the hardest stainless steels.
INCONEL a family of AUSTENITIC NICKEL-CHROMIUM-BASED SUPERALLOYS	600	1150	Inconel alloys are oxidation- and corrosion-resistant materials well suited for service in extreme environments subjected to high pressure and kinetic energy. When heated, Inconel forms a thick and stable passivating oxide layer protecting the surface from further attack. Inconel retains strength over a wide temperature range, attractive for high-temperature application.
	601		
	800		

Mineral Insulated Thermocouple Compensation Cable

Definition

Mineral Insulated Thermocouple Compensation Cable is consisted of 3 parts: metal sheath in stainless steel, copper or other metal; insulator such as magnesium oxide or alumina; compensation conductor. After assembled, it becomes the solid body by drawing(or swaging); the structure is different with conventional compensation wire. Its mainly usage is temperature compensation on thermocouple cold junction.

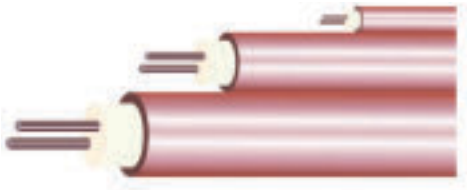
Properties

Compared with the conventional compensation wire, Mineral insulated thermocouple compensation cable has the advantages of pressure resistance , shock resistance, high temperature resistance, anti-radiation, anti-explosion, high mechanical strength and long working life.

Usage

It is used to connect the hot electrode (the cold junction of the thermocouple) with the Temp. Controller, which compose the temperature measurement system. It can be fit for a variety of temperature measurement devices. Its effects is according to "IEC584-3" standards.
Mineral Insulated Thermocouple Compensation Cable, as upgrading products of the conventional type,is popular be used in Electricity, Metallurgy, Petroleum, Chemical Industry, intelligent equipment and defense and other high-tech industries.

POPULAR PRODUCT
Copper Sheath Cable
B/R/S Positive :Cooper
Negative : Copper-Nickel Alloy
K/N/E/J/T Type is Available.
Stainless Steel Sheath Is Available.



Other Products

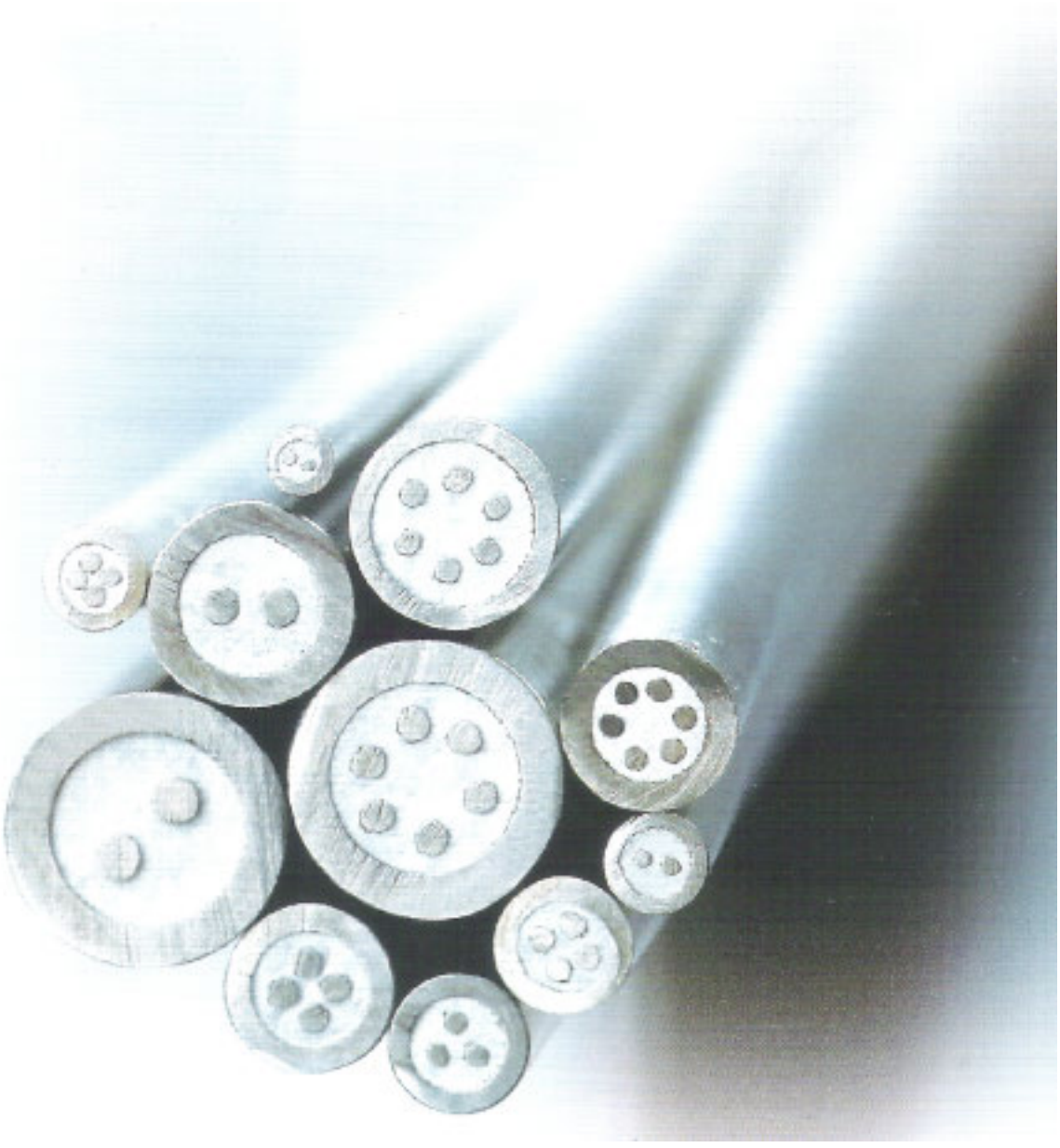
Taisuo technology focuses on developing the serialization products of thermal management system with high quality. In addition to the mineral insulated cable series, we can also provide the Temperature Sensors, Sensor Related Accessories, Temperature Controllers etc.

Hex Fittings & Compression Fittings

Terminal blocks

Sensor connection heads

Temperature controllers



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