CNC machining materials are so abundant that often companies do not always have a good grasp on the issue of material selection, and even experienced product designers and engineers can face the same problems. We have therefore put a lot of effort into collating information on the 7 main categories of CNC machining materials that are commonly used, and we hope that this information will be of help to you. If you have a requirement for CNC machining services, please feel free to contact us.

**CNC material categories**

1. Aluminium alloy material
   - a. Aluminium alloy 6061
   - b. Aluminium alloy 5052
   - c. Aluminium alloy 2A12
   - d. Aluminium alloy 7075

2. Stainless steel
   - a. Stainless steel 303
   - b. Stainless steel 304
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- c. Stainless steel 316
- d. Stainless steel 316L
- e. Stainless steel 420
- f. Stainless steel 430
- g. Stainless steel-17-4PH
- h. Stainless steel 301
- i. Stainless steel 321

3. Alloy steel
   - a. Q235 (A3 steel)
   - b. 45 steel
   - c. Cr12
   - d. 3Cr13
   - e. GCr15
   - f. 40Cr
   - g. Spring steel-65Mn
   - h. Mould steel SKD1

4. Copper alloys
   - a. Brass-H59
   - b. Brass-H62
   - c. Purple copper-T2
   - d. Oxygen-free copper-TU2
   - e. Tin bronze – QSn-6-6-3
   - f. Beryllium copper-C17200
5. Aluminium alloy material
   - a. Electrotechnically pure iron-DT4C
   - b. Titanium alloy-TC4
   - c. Magnesium alloy-AZ91D

6. Plastics
   - a. Engineering plastics-ABS
   - b. Polytetrafluoroethylene-PTFE
   - c. Cyclosteel-POM
   - d. Bakelite
   - e. Plexiglass-PMMA
   - f. Polypropylene-PP
   - g. Polyphenylene sulfide-PPS
   - h. Polyurethane-PU (Urethane)
   - i. Polyvinyl chloride-PVC
   - j. Epoxy sheet-FR-4
   - k. Polyethylene-HDPE
   - l. Polyethylene-LDPE
   - m. Nylon-PA6
   - n. Nylon-PA66
   - o. Polycarbonate-PC
   - p. Polyetheretherketone-PEEK

7. Special materials and others
   - a. Carbon fibre sheets
1、Aluminium materials

a. Aluminium alloy 6061

Introduction:
6061 aluminium alloy is a high-quality aluminium alloy produced by a heat treatment pre-drawing process.

6061 aluminium is a heat treatable and strengthenable alloy with good formability, weldability and machinability while having medium strength and maintaining good operability after annealing. The main alloying element of 6061 aluminium is magnesium and silicon and forms the Mg2Si phase. If a certain amount of manganese and chromium can neutralise the bad effects of iron; sometimes a small amount of copper or zinc is added to improve the strength of the alloy without making its corrosion resistance significantly reduced; there is a small amount of copper in the conductive material to offset the bad effects of titanium and iron on conductivity; zirconium or titanium can refine the grain and control the recrystallisation organisation; in order to improve the machinability, lead and bismuth can be added. In Mg2Si solid solution in aluminium, so that the alloy has artificial age-hardening function.

Application areas:
6061-T651 is the main alloy of 6061 aluminium alloy, but its magnesium, silicon alloy characteristics, with excellent processing performance, excellent welding characteristics and plating, good corrosion resistance, high toughness and no deformation after processing, dense material without defects and easy polishing, easy to colour film, excellent oxidation effect and other excellent characteristics.

1. the application of the sheet and strip is widely used in decoration, packaging, construction, transportation, electronics, aviation, aerospace, weapons and other industries.
2. Aerospace aluminum is used to make aircraft skins, fuselage frames, beams, rotor blades, propellers, fuel tanks, wall plates and landing gear struts, as well as rocket forging rings, spacecraft wall plates, etc.

3. Transportation aluminum is used for automobile, underground vehicle, railway bus, high-speed bus body structure parts materials, car doors and windows, shelves, car engine parts, air conditioners, radiators, body panels, wheels and naval vessels with materials.

4. The packaging of aluminum all aluminum cans can material is mainly in the form of sheet and foil as metal packaging materials, made of cans, lids, bottles, barrels, packaging foil. Widely used in beverage, food, cosmetics, drugs, cigarettes, industrial products and other packaging.

5. Aluminum for printing is mainly used for making PS plates, aluminum-based PS plates are a new type of material for the printing industry, used for automated plate making and printing.

6. Aluminum alloy for building decoration is widely used in building frame, doors and windows, ceiling, decorative surface, etc. because of its good corrosion resistance, sufficient strength, excellent process performance and welding performance. Such as a variety of architectural doors and windows, curtain wall with aluminum profiles, aluminum curtain wall plate, pressure plate, pattern plate, colour coated aluminum plate, etc.

7. Aluminum for electronics and home appliances are mainly used in various busbars, racking wires, conductors, electrical components, refrigerators, air conditioners, cables and other fields. Specifications: round bar, square bar. Representative uses include aerospace fixtures, electrical fixtures, communication fields.

- **6061 aluminium alloy elements**
  The main alloying element of 6061 aluminium alloy is magnesium and silicon, and forms Mg2Si phase. If contain a certain amount of manganese and chromium, can neutralize the bad effect of iron; sometimes also add a small amount of copper or zinc, in order to improve the strength of the alloy, but does not make its corrosion resistance has a significant reduction; conductive materials and a small amount of copper, in order to offset the titanium and iron.
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materials and a small amount of copper, in order to offset the titanium and iron on the bad influence of electrical conductivity; zirconium or titanium can refine the grain and control recrystallization organization; in order to improve the machinability, can add lead and bismuth. In Mg2Si solid solution in aluminum, so that the alloy has artificial aging hardening function. 6061 aluminum alloy in the main alloy elements for magnesium and silicon, with medium strength, good corrosion resistance, weldability, oxidation effect is good.

- **magnesium aluminum 6061 characteristics**
  Magnesium aluminum 6061-T651 is the main alloy of the 6 series alloy, is a high quality aluminum alloy products by heat treatment pre-stretching process; magnesium aluminum 6061 has excellent processing performance, good corrosion resistance, high toughness and processing after the non-deformation, easy colour film, excellent oxidation effect and other excellent features.

Main uses: Widely used in various industrial structural parts requiring certain strength and high corrosion resistance, such as manufacturing trucks, tower buildings, ships, trams, railway vehicles.

- Typical uses of 6061 include aerospace fixtures, electrical fixtures, communications, and also widely used in automated mechanical parts, precision machining, mould making, electronics and precision instruments, SMT, PC board solder carriers, etc.

**Chemical composition:**

- **Unit:** %
- Copper Cu :0.15~0.4
- Manganese Mn :0.15
- Magnesium Mg :0.8~1.2
- Zinc Zn :0.25
- Chromium Cr :0.04~0.35
- Titanium Ti :0.15
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Titanium Ti: 0.15
Silicon Si: 0.4 ～ 0.8
Iron Fe: ≤0.7
Aluminium Al: remainder

Mechanical properties:

- 6061 has an ultimate tensile strength of 205 MPa or more
- Yield strength under compression 55.2 MPa
- Coefficient of elasticity 68.9 GPa
- Bending ultimate strength 228 MPa
- Bending Yield Strength 103 MPa

Heat treatment process:

- Rapid annealing: heating temperature 350 ～ 410 °C; with the effective thickness of the material, holding time between 30 ～ 120min; air or water cooling.
- High temperature annealing: heating temperature 350 ～ 500 °C; finished thickness ≥ 6mm, holding time of 10 ～ 30min, less than 6mm, heat through until; air cooling.
- Low temperature annealing: heating temperature 150 ～ 250 °C; holding time of 2 ～ 3h; air or water cooling.
- Homogenisation: 570°C, holding time 7h, air-cooled.

Corresponding grades:

- National standard: 6061 LD30 GB/T 3190-2008
- ISO: AlMg1SiCu ISO 209.1-1989
b. Aluminium alloy 5052

Introduction:
5052 aluminium alloy belongs to the Al-Mg system of alloys, the use of a wide range, especially in the construction industry can not do without this alloy, is the most promising alloy. 5052 aluminium alloy has good corrosion resistance, excellent weldability, good cold workability and medium strength. 5052 aluminium alloy is mainly made of magnesium, which has good forming and processing properties, corrosion resistance, weldability and medium strength. 5052 aluminium alloy is used in the manufacture of aircraft fuel tanks, fuel pipes, as well as sheet metal parts for transportation vehicles and ships, instruments, street light brackets and rivets, hardware products, electrical – apparatus shells, etc.

5052 aluminum alloy is one of the most widely used rust-proof aluminum, this alloy has high strength, especially fatigue strength: plasticity and corrosion resistance is high, can not be heat-treated to strengthen, plasticity is still good when semi-cold hardening, plasticity is low when cold hardening, good corrosion resistance, good weldability, poor machinability, polishable. Uses are mainly for low load parts requiring high plasticity and good weldability, working in liquid or gaseous media, such as oil tanks, petrol or lubricating oil ducts, various liquid containers and other small load parts made by deep drawing: the wire is used for rivets.
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Used in the manufacture of aircraft fuel tanks, fuel pipes, as well as sheet metal parts for transport vehicles and ships, instruments, street light brackets and rivets, hardware products, electrical – appliance housings, etc.

**Chemical composition:**

- Aluminium Al: remainder
- Silicon Si: ≤0.25
- Cu : ≤0.10
- Magnesium Mg: 2.2~2.8
- Zinc Zn: ≤0.10
- Manganese Mn: ≤0.10
- Chromium Cr: 0.15~0.35
- Iron Fe: ≤0.40
- Note: Single:≤0.05;Total:≤0.15

**Mechanical properties:**

- Tensile strength $\sigma_b$ (MPa) 173-244
- Conditional yield strength $\sigma_{0.2}$ (MPa) ≥70
- Density 2.68 g/cm³
- Specimen size: all wall thicknesses

Note: Longitudinal mechanical properties of tubes at room temperature
c. Aluminium alloy 2A12

Introduction:
2A12 aluminium alloy is a kind of high-strength hard aluminium, which can be strengthened by heat treatment; 2A12 aluminium alloy has good weldability in spot welding, but has the tendency to form intergranular cracks when using gas welding and argon arc welding; 2A12 aluminium alloy has good machinability after cold work hardening. Corrosion resistance is not high, often using anodic oxidation treatment and painting methods or surface addition of aluminum cladding layer to improve corrosion resistance.

Application areas:
It is mainly used to make various high load parts and components (but not including stamping forgings) such as aircraft skeleton parts, skins, spacers, wing ribs, wing beams, rivets and other working parts below 150°C.

Chemical composition:

- Aluminium Al: remainder
- Silicon Si: ≤ 0.50
- Cu: 3.8～4.9
- Magnesium Mg: 1.2～1.8
- Zinc Zn: ≤ 0.30
- Manganese Mn: 0.30～0.9
- Titanium Ti: ≤ 0.15
- Nickel Ni: ≤ 0.10
- Iron Fe: 0.000 to 0.500
- Fe + Ni Fe + Ni: 0.000 to 0.500

Note: Individual: ≤ 0.05; Total: ≤ 0.10
d. Aluminium alloy 7075

Introduction:

7075 aluminium alloy is a cold treated wrought alloy with high strength, far superior to soft steel. 7075 is one of the most powerful alloys commercially available. General corrosion resistance, good mechanical properties and anodic reaction. The fine grain size allows for better depth drilling performance, increased tool wear resistance and thread rolling with a difference. Zinc is the main alloying element in 7075 and the addition of magnesium to an alloy containing 3% to 7.5% zinc results in the formation of MgZn2, which has a significant strengthening effect and makes the alloy far superior to aluminium-zinc binary alloys in terms of heat treatment. By increasing the zinc and magnesium content of the alloy, the tensile strength is further improved, but its resistance to stress corrosion and spalling corrosion is subsequently reduced. The 7075 material is generally alloyed with a small amount of copper and chromium, and the 7075-T651 aluminium alloy is particularly good, being the best of the aluminium alloys, with high strength and far superior to any soft steel. This alloy also has good mechanical properties and anodic reaction.

Typical applications include aerospace, mould processing, mechanical equipment, jigs and fixtures, especially for aircraft structures and other highly stressed structures requiring high strength and corrosion resistance.

Application areas:

Aerospace industry, blow moulding (bottle) moulds, ultrasonic plastic welding moulds, golf ball heads, shoe moulds, paper and plastic moulds, foam forming moulds, de-waxing moulds, paradigms, jigs, machinery and equipment, mould processing for making high-end aluminium alloy bicycle frames.

Chemical composition:

- Silicon Si: 0.40
- Silicon Si: 0.40
- Iron Fe: 0.50
- Copper Cu: 1.2-2.0
- Manganese Mn: 0.30
- Magnesium Mg: 2.1-2.9
- Chromium Cr: 0.18-0.28
- Zinc Zn: 5.1-6.1
- Titanium Ti: 0.20
- Aluminium Al: remainder
- Other: Individual: 0.05 Total: 0.15

Mechanical properties:
- Tensile strength: 524Mpa
- Yield strength 0.2%: 455Mpa
- Modulus of elasticity E: 71GPa
- Hardness: 150HB
- Density: 2.81g/cm^3 [1]
- Poisson’s ratio: 0.33

**Corresponding grades:**

- Chinese Standard: 7A09 GB/T3190-2008
- Non-standard: 76528 IS 733-2001 IS737-2001
- Russian Standard: B95/1950 rocT 4785-1974
2. Stainless steel

a. Stainless steel 303

Introduction:

303 stainless steel is an austenitic free-cutting stainless acid resistant steel. To improve the performance of this steel, molybdenum of not more than 0.60 % can be added to the steel to resist ablation.

Application areas:

Petroleum, electronics, chemical, pharmaceutical, light textile, food, machinery, construction, nuclear power, aerospace, military and other industries.

Chemical composition:

- C : ≤0.15%
- Si : ≤1.00%
- Mn : ≤2.00%
- P : ≤0.20%
- S : ≥ 0.15%
- Cr : 17.00-19.00 (%)
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- Cr : 17.00 - 19.00 (%)
- Ni : 8.00 - 10.00 (%)
- Mo : ≤ 0.06%

**Mechanical properties:**

- Tensile strength $\sigma_b$ (MPa): ≥ 520
- Conditional yield strength $\sigma_{0.2}$ (MPa): ≥ 205
- Elongation $\delta$ (%) : ≥ 40
- Section shrinkage $\psi$ (%) : ≥ 50
- Hardness : HB ≤ 187HB; HRC ≤ 90HRB; HV ≤ 200HV

**Heat treatment process:**

Heat treatment specification: solid solution 1010 ~ 1150 °C fast cooling.
Metallographic organisation: the organisation is characterised by austenitic type.

**b. Stainless steel 304**

**Introduction:**

304 stainless steel is a common material in stainless steel, with a density of 7.93 g/cm³; the industry is also called 18/8 stainless steel, meaning that it contains more than 18% chromium and more than 8% nickel; it is resistant to high temperatures of 800°C, has good processing properties and high toughness, and is widely used in industrial and furniture decoration industries and the food and medical industry. However, it should be noted that food grade 304 stainless steel is more stringent in its content index compared to ordinary 304 stainless steel. For example, the international definition of 304 stainless steel is basically containing mainly chromium 18%-20% nickel 8%-10%, but food grade 304 stainless steel is containing chromium 18% and nickel 8%, allowing a certain range of fluctuations.
containing chromium 18% and nickel 8%, allowing a certain range of fluctuations, and limit the content of various heavy metals. In other words, 304 stainless steel is not necessarily food-grade 304 stainless steel.

The market is commonly marked with 06Cr19Ni10, SUS304, where 06Cr19Ni10 generally indicates national standard production, 304 generally indicates ASTM standard production, SUS 304 indicates Japanese standard production.

304 is a general purpose stainless steel that is widely used for making equipment and machine parts that require good overall performance (corrosion resistance and formability). In order to maintain the inherent corrosion resistance of stainless steel, the steel must contain more than 18% chromium and 8% nickel. 304 stainless steel is a grade of stainless steel produced in accordance with ASTM standards.

**Application areas:**

304 stainless steel is one of the most widely used chromium-nickel stainless steels, as a widely used steel, has good corrosion resistance, heat resistance, low temperature strength and mechanical properties; stamping, bending and other hot workability is good, no heat treatment hardening phenomenon (use temperature -196 °C ~ 800 °C). Corrosion resistant in the atmosphere, in case of industrial atmosphere or heavily polluted areas, prompt cleaning is required to avoid corrosion. Suitable for food processing, storage and transport. Good machinability and weldability. Plate heat exchangers, bellows, household goods (class 1 and 2 cutlery, cabinets, indoor plumbing, water heaters, boilers, bathtubs), automotive parts (windscreen wipers, mufflers, moulded products), medical appliances, building materials, chemical, food industry, agriculture, marine components, etc. The content of which is strictly controlled 304 stainless steel, which can also be called food grade 304 stainless steel.

Most of the use requirements are to maintain the original appearance of the building over time. In determining the type of stainless steel to be selected, the main considerations are the aesthetic standards required, the corrosiveness of the atmosphere where it is to be used and the cleaning regime to be adopted. However, other applications are increasingly simply seeking structural integrity or
Other applications are increasingly simply seeking structural integrity or impermeability. Examples include roofs and sidewalls of industrial buildings. In these applications, the cost of construction to the owner may be more important than aesthetics, and surfaces that are not very clean are fine. The use of 304 stainless steel works reasonably well in dry indoor environments. However, to maintain its appearance outdoors in rural and urban areas, it needs to be cleaned frequently. In heavily polluted industrial and coastal areas the surfaces can be very dirty and even rusty.

However, to obtain the aesthetic effect in an outdoor environment, nickel-containing stainless steel is required. Therefore, 304 stainless steel is widely used for curtain walls, sidewalls, roofs and other architectural applications, but in heavily aggressive industrial or marine atmospheres, 316 stainless steel is preferable. Stainless steel sliding doors, the superiority of using stainless steel in structural applications has been well recognised. Several design guidelines include 304 and 316 stainless steel. Because the “duplex” stainless steel 2205 has combined good atmospheric corrosion resistance with high tensile and elastic strength, this steel is also included in European guidelines. Product shapes In practice, stainless steels are manufactured in a full range of standard metal shapes and sizes, but there are also many special shapes. The most common products are made from sheet and strip, but special products are also produced from medium-thick plates, for example, hot-rolled structural sections and extruded structural sections. And there are also round, oval, square, rectangular and hexagonal welded or seamless tubes and other forms of products, including profiles, bars, wire rod and castings.

**Mechanical properties:**

- Tensile strength $\sigma_b$ (MPa) $\geq 515-1035$
- Conditional yield strength $\sigma_0.2$ (MPa) $\geq 205$
- Elongation $\delta 5$ (%) $\geq 40$
- Section shrinkage $\psi$ (%) $\geq$?
- Hardness: $\leq 201$ HBW; $\leq 92$ HRB; $\leq 210$ HV
- Density ($20^\circ C$, $\sigma$/cm$^3$): 7.93

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- Density (20°C, g/cm³): 7.93
- Melting point (°C): 1398~1454
- Specific heat capacity (0~100°C, KJ·kg⁻¹·K⁻¹): 0.50
- Thermal conductivity (W·m⁻¹·K⁻¹): (100°C) 16.3, (500°C) 21.5
- Coefficient of linear expansion (10⁻⁶·K⁻¹): (0~100°C) 17.2, (0~500°C) 18.4
- Resistivity (20°C, 10⁻⁶·Ω·m²/m): 0.73
- Longitudinal modulus of elasticity (20°C, KN/mm²): 193

**Corresponding grades:**

- GB1220-2007 Stainless steel bars (Grade I) GB4241-84 Stainless steel welded discs (Grade H)
- GB4356-2002 Stainless steel welded disc garden (I grade) GB1270-80 Stainless steel pipe (I grade)
- GB12771-2000 Stainless steel welded pipes (Grade Y) GB3280-2007 Stainless steel cold plates (Grade I)
- GB4237-2007 Stainless steel hot plates (Grade I) GB4239-91 Stainless steel cold strips (Grade I)

**c. Stainless steel 316**

**Introduction:**

Characteristics: Because of the addition of Mo, its corrosion resistance, atmospheric corrosion resistance and high temperature strength is particularly good, can be used in harsh conditions; processing hardening excellent (non-magnetic); high temperature strength excellent; solid solution state non-magnetic; cold-rolled product appearance glossy, beautiful; relative to 304 stainless steel, the price is higher.
316 stainless steel because of the addition of Mo elements, so that its corrosion resistance, and high temperature strength has a greater increase, high temperature resistance can reach 1200-1300 degrees, can be used in harsh conditions.

**Application areas:**

Equipment for use in seawater, chemical, dye, paper, oxalic acid, fertiliser production equipment; photographic, food industry, coastal facilities, ropes, CD rods, bolts, nuts.

**Chemical composition:**

- P ≤ 0.035
- S ≤ 0.03
- Ni: 10.0-14.0
- Cr: 16.0-18.5
- Mo: 2.0-3.0

d. Stainless steel 316L

**Introduction:**

316L is a stainless steel material grades, AISI 316L is the corresponding American standard, sus 316L is the corresponding Japanese standard. China’s unified numerical code for S31603, the standard grade for 022Cr17Ni12Mo2 (new standard), the old grade for 00Cr17Ni14Mo2, said to contain mainly Cr, Ni, Mo, the number indicates the approximate percentage contained. The national standard is GB/T 20878-2007 (current version).
316L has a wide range of applications in the chemical industry due to its excellent corrosion resistance. 316L is also a derivative steel grade belonging to the 18-8 austenitic stainless steel, with 2 to 3% Mo elements added. On the basis of 316L, many steel grades have also been derived, such as 316Ti with a small amount of Ti, 316N with a small amount of N, and 317L with increased Ni and Mo content.

Most of the 316L available on the market is produced according to the American Standard. For cost reasons, steel mills generally try to bring the Ni content of their products down to the lower limit. The American Standard specifies that the Ni content of 316L is 10-14%, while the Japanese Standard specifies that the Ni content of 316L is 12-15%. According to the minimum standard, the American Standard and the Japanese Standard have a 2% difference in Ni content, which is reflected in the price or is quite huge, so customers still need to see when buying 316L products, whether the product is referenced to ASTM or JIS standards.

The Mo content of 316L gives the steel excellent resistance to pitting and can be safely used in environments containing halogen ions such as Cl-. As 316L is mainly used for its chemical properties, steel mills require slightly less surface inspection for 316L (compared to 304), and customers with higher surface requirements should strengthen their surface inspection efforts.

**Chemical composition:**

- Carbon C: ≤ 0.030
- Silicon Si: ≤1.00
- Manganese Mn: ≤2.00
- Sulphur: ≤0.030
- Phosphorus P: ≤0.045
- Chromium Cr: 16.00~18.00
- Nickel Ni: 10.00~14.00
- Molybdenum Mo: 2.00 to 3.00

**Mechanical properties:**

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Mechanical properties:

- Tensile strength $\sigma_b$ (MPa): $\geq 480$
- Conditional yield strength $\sigma_{0.2}$ (MPa): $\geq 177$
- Elongation $\delta 5$ (%): $\geq 40$
- Shrinkage at break $\psi$ (%): $\geq 60$
- Hardness: $\leq 187$HB;$\leq 90$HRB;$\leq 200$HV
- Density: 7.98g/cm³.
- Specific heat capacity ratio (20°C): 0.502J/(g*K)

Heat treatment process:

Solid solution 1010 to 1150°C fast cooling.

e. Stainless steel 420

Introduction:

420 stainless steel, 420 stainless steel is 420 “edge tool grade” martensitic steel, similar to Brinell high chromium steel, the earliest stainless steel. 420 has a certain wear resistance and corrosion resistance, high hardness, its price is the lower class of stainless steel ball, suitable for the general requirements of stainless steel in the work environment. 420 stainless steel is suitable for Various types of precision machinery, bearings, electrical, equipment, instruments, meters, transportation tools, household appliances, etc. Mostly used in the manufacture of parts resistant to corrosion by atmosphere, water vapour, water and oxidising acids.

Application areas:
Suitable for all kinds of precision machinery, bearings, electrical, equipment, instruments, meters, transportation tools, household appliances, etc. Mostly used in the manufacture of parts resistant to corrosion by atmosphere, water vapour, water and oxidising acids.

**Chemical composition:**

- Carbon C: 0.16~0.25
- Manganese Mn: ≤1.00
- Silicon Si: ≤1.00
- Chromium Cr: 12.0~14.0
- Nickel Ni: ≤0.75
- Phosphorus P: ≤0.04
- Sulphur S: ≤0.03

**Note:**

- ① single value unless otherwise specified, are the highest value;
- ② used in some pipe making process, some models of austenitic stainless steel nickel content must be slightly higher than the value shown in the table;
- ③ arbitrary;
- ④ the highest Ta content of 0.10%;
- ⑤ the highest content of 0.75%;
- ⑥ the highest content of 0.70%

**Mechanical properties:**

- Tensile strength σb (MPa): quenched and tempered, ≥635
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- Conditional yield strength $\sigma_{0.2}$ (MPa): quenched and tempered, $\geq 440$
- Elongation $\delta_5$ (%): Quenched and tempered, $\geq 20$
- Section shrinkage $\psi$ (%): quenched and tempered, $\geq 50$
- Impact power $A_{kv}$ (J): quenched and tempered, $\geq 63$
- Hardness: annealed, $\leq 223$HB;
- quenched and tempered, $\geq 192$HB

f. Stainless steel 430

Introduction:

430 stainless steel is a general-purpose steel with good corrosion resistance, better thermal conductivity than austenite, smaller coefficient of thermal expansion than austenite, heat-resistant fatigue, added stabilizing element titanium, good mechanical properties of the weld area. 430 stainless steel is used for architectural decoration, fuel burner components, household appliances, household appliances components. 430F is a steel with easy cutting properties added to 430 steel, mainly used for automatic lathes, bolts and nuts. 430LX is added to 430 steel with Ti or Nb, reduced C content, improved machinability and weldability, mainly used for hot water tanks, hot water systems, sanitary appliances, household durable appliances, bicycle flywheels, etc. Due to its chromium content, it is also known as 18/0 or 18-0. Compared to 18/8 and 18/10, it contains slightly less chromium and has a correspondingly lower hardness.

Application areas:

Mainly used in hot water tanks, hot water supply systems, sanitary ware, durable household appliances, bicycle flywheels, etc.

Chemical composition:

- Carbon (C): $\leq 0.12\%$
- Carbon (C) \( \leq 0.12\% \)
- Silicon (Si) \( \leq 0.75\% \)
- Manganese (Mn) \( \leq 1.00\% \)
- Phosphorus (P) \( \leq 0.040\% \)
- Sulphur (S) \( \leq 0.030\% \)
- Nickel (Ni) \( \leq 0.60\% \) (may contain)
- Chromium (Cr) 16.00\text{~}18.00\%

**Mechanical properties:**

- Density: 7.75g/cm³
- Melting point: 1427°C
- Coefficient of expansion: mm/°C (at 20-100°C)
- Young’s modulus: kN/mm²
- Modulus of rigidity: kN/mm²
- Application standard: n/a (UNS)

**g. Stainless steel-17-4PH**

**Introduction:**

17-4PH stainless steel, is a martensitic precipitation hardening stainless steel, equivalent to the Chinese grade: 0Cr17Ni4Cu4Nb.

17-4PH is a precipitation-hardening steel grade with the addition of copper. 17-4PH is used in the manufacture of shafts and turbine components.
Offshore platforms, helicopter decks, other platforms, food industry, pulp and paper industry, aerospace (turbine blades), mechanical components, nuclear waste bins.

Chemical composition:

- Carbon C: \(\leq 0.07\)
- Manganese Mn: \(\leq 1.00\)
- Silicon Si: \(\leq 1.00\)
- Chromium Cr: 15.5~17.5
- Nickel Ni: 3.0~5.0
- Phosphorus P: \(\leq 0.04\)
- Sulphur S: \(\leq 0.03\)
- Copper Cu: 3.0~5.0
- Niobium+Tantalum Nb+Ta: 0.15~0.45

Mechanical properties:

- Tensile strength \(\sigma_b\) (MPa): 480°C aging, \(\geq 1310\); 550°C aging, \(\geq 1060\); 580°C aging, \(\geq 1000\); 620°C aging, \(\geq 930\)
- Conditional yield strength \(\sigma_{0.2}\) (MPa): 480°C aging, \(\geq 1180\); 550°C aging, \(\geq 1000\); 580°C aging, \(\geq 865\); 620°C aging, \(\geq 725\)
- Elongation \(\delta 5\) (%): 480°C aging, \(\geq 10\); 550°C aging, \(\geq 12\); 580°C aging, \(\geq 13\); 620°C aging, \(\geq 16\)
- Section shrinkage \(\psi\) (%): 480°C aging, \(\geq 40\); 550°C aging, \(\geq 45\); 580°C aging, \(\geq 50\)
Section shrinkage: ψ(%) 480 °C aging, ≥40; 550 °C aging, ≥45; 580 °C aging, ≥45; 620 °C aging, ≥50

- Hardness: solid solution, ≤363HB and ≤38HRC; 480 °C aging, ≥375HB and ≥40HRC; 550 °C aging, ≥331HB and ≥35HRC; 580 °C aging, ≥302HB and ≥31HRC; 620 °C aging, ≥277HB and ≥28HRC

Heat treatment process:

- 1) Solid solution 1020～1060 ℃ fast cooling;
- 2) 480 °C aging, after solid solution treatment, 470～490 °C air cooling;
- 3) 550 °C aging, after solid solution treatment, 540～560 °C air cooling;
- 4) 580 °C aging, after solid solution treatment, 570～590 ℃ air-cooled;
- 5) 620 °C aging, after solid solution treatment, 610～630 ℃ air-cooled.

Metallographic organization: the organization is characterized by precipitation hardening type.

**h. Stainless steel 301**

**Introduction:**

301 stainless steel strip is a sub-stable austenitic stainless steel, in full solid solution conditions, with a fully austenitic organization. In the stainless steel, 301 is the most easily cold deformation of steel, through the cold deformation process can make the steel strength, hardness, and retain sufficient plastic, toughness, plus this steel in atmospheric conditions with good rust resistance, but in the reducing medium corrosion resistance is not good, in acid, alkali and salt and other chemical media corrosion resistance is poor, so not recommended for the corrosion of harsh environments. 301 is mainly used in the cold processing state to withstand The steel is mainly used in a cold-worked state for equipment components that are subjected to high loads and wish to reduce the weight of the equipment and not rust. In addition, the steel’s susceptibility to work-hardening...
301 tends to work harden when deformed and is used where high strength is required.

**Chemical composition:**

- C: \(\leq 0.15\),
- Si: \(\leq 1.0\),
- Mn: \(\leq 2.0\),
- Cr: 16.0~18.0,
- Ni: 6.0-8.0,
- S: \(\leq 0.03\),
- P: \(\leq 0.045\)

**Mechanical properties:**

- Tensile strength \(\sigma_b\) (MPa): \(\geq 520\)
- Conditional yield strength \(\sigma_{0.2}\) (MPa): \(\geq 205\)
- Elongation \(\delta 5\) (%): \(\geq 40\)
- Section shrinkage \(\psi\) (%): \(\geq 60\)
- Hardness : \(\leq 187\)HB; \(\leq 90\)HRB; \(\leq 200\)HV

**Heat treatment process:**

- Solid solution 1010 to 1150°C fast cooling.

**i. Stainless steel 321**
321 stainless steel is a material with excellent high temperature stress rupture (Stress Rupture) performance and high temperature resistance (Creep Resistance) stress mechanical properties are better than 304 stainless steel.

**Application areas:**

Applications for resistance to grain boundary corrosion require high chemical, coal and oil industry field open-air machines, heat resistant parts for building materials and parts with heat treatment difficulties.

- 1. Oil waste gas combustion pipes
- 2. Engine exhaust pipes
- 3. Boiler casings, heat exchangers, heating furnace components
- 4. Sound-deadening components for diesel engines
- 5. Boiler pressure vessels
- 6. Chemical transport vehicles
- 7. Expansion joints
- 8. Spiral welded pipes for furnace piping and dryers

**Chemical composition:**

- Carbon: 0.08
- Silicon: 1.00
- Manganese: 2.00
- Phosphorus: 0.045
- Sulphur: 0.030
- Nickel: 9.00-12.00
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- Chromium: 17.00-19.00
- Titanium: 5C-0.70
- Corresponding grades:
  - US grades: 321, S32100, TP321
  - Japanese grades: SUS321
  - British grades: 304S12, 321920
  - German grade: X10CrNiTi189

3. Alloy steel

a. Q235 (A3 steel)

Introduction:

Q235 plain carbon structural steel is also known as A3 plate.
Common carbon structural steel – plain plate is a material of steel.

The yield value decreases as the thickness of the material increases (plate thickness/diameter ≤ 16mm, yield strength 235MPa; 16mm < plate thickness/diameter ≤ 40mm, yield strength 225MPa; 40mm < plate thickness/diameter ≤ 60mm, yield strength 215MPa; 60mm < plate thickness/diameter ≤ 100mm, yield strength 205MPa. (100mm<plate thickness/diameter≤150mm, yield strength 195MPa; 150mm<plate thickness/diameter≤200mm, yield strength 185MPa).

Due to the lower carbon content, the overall performance is better, and the strength, plasticity and welding properties are better matched and most widely used.

Composed of Q + number + quality grade symbol + deoxidation method symbol. Its
Composed of Q + number + quality grade symbol + deoxidation method symbol. Its steel number is crowned with “Q”, representing the yield point of the steel, followed by a number indicating the value of the yield point in MPa e.g. Q235 indicates a carbon structural steel with a yield stress ($\sigma_s$) of 235 MPa.

Where necessary, the steel number may be followed by a symbol indicating the quality grade and method of deoxidation.

The quality grade symbols are A, B, C and D respectively.

Deoxidation method symbols: F for boiling steel.

b indicates semi-sedated steel.

Z for quiescent steel.

TZ for special sedated steel.

Sedated steel may not be marked with a symbol, i.e. both Z and TZ may not be marked. For example, Q235-AF indicates A grade boiling steel.

Carbon steels for special purposes, such as bridge steels, marine steels, etc., are basically expressed in the same way as carbon structural steels, but with an additional letter at the end of the steel number indicating the purpose.

**Application areas:**

- A large number of applications in the construction and engineering structure. C, D grade steel can also be used for some professional steel.
- It can be used for various mould handles and other unimportant mould parts.
- The Q235 steel is used as punch material, which is quenched and used directly without tempering, with a hardness of 36~40HRC, which solves the phenomenon of the punch breaking in use.

**Chemical composition:**

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Chemical composition:

- Q235 is divided into four grades A, B, C and D (GB/T 700-2006)
- Q235A grade contains $C \leq 0.22\%$ Mn $\leq 1.4\%$ Si $\leq 0.35\%$ S $\leq 0.050$ P $\leq 0.045$
- Q235B with $C \leq 0.20\%$ Mn $\leq 1.4\%$ Si $\leq 0.35\%$ S $\leq 0.045$ P $\leq 0.045$ (carbon content may not be greater than 0.22% with the consent of the demander)
- Q235C with $C \leq 0.17\%$ Mn $\leq 1.4\%$ Si $\leq 0.35\%$ S $\leq 0.040$ P $\leq 0.040$
- Q235D with $C \leq 0.17\%$ Mn $\leq 1.4\%$ Si $\leq 0.35\%$ S $\leq 0.035$ P $\leq 0.035$

Mechanical properties:

- Density: $7.85g/cm^3$
- Modulus of elasticity (E/Gpa): 200~210
- Poisson’s ratio ($\nu$): 0.25~0.33
- Tensile strength ($\sigma_b$/MPa): 370-500
- Yield strength (thickness or diameter less than or equal to 16mm): 235
- Coefficient of linear expansion of material $\alpha$ (1/°C): 1.20E-05
- Elongation ($\delta$ 5%):
  - $\geq 26$ ($a \leq 16mm$)
  - $\geq 25$ ($a > 16-40mm$)
  - $\geq 24$ ($a > 40-60mm$)
  - $\geq 23$ ($a > 60-100mm$)
  - $\geq 22$ ($a > 100-150mm$)
  - $\geq 21$ ($a > 150mm$)

where $a$ is the thickness or diameter of the steel.
Heat treatment process:

Quenching temperature is 950°C, heated in a salt bath and quenched by cooling in 10% NaCl brine.

b. 45 steel

Introduction:

45# is a grade of high quality carbon structural steel, corresponding to Japanese S45C, American 1045 and German C45, which is characterised by its higher strength and resistance to deformation than ordinary A3 steel.

Chemical composition:

- Carbon C: 0.42 to 0.50.
- Chromium Cr: \( \leq 0.25 \).
- Manganese Mn: 0.50 to 0.80.
- Nickel Ni: \( \leq 0.25 \).
- Phosphorus P: \( \leq 0.035 \).
- Sulphur S: \( \leq 0.035 \).
- Silicon Si: 0.17~0.37

Mechanical properties:

- \( \sigma _{b}\text{Mpa}\geq 600 \)
- \( \sigma _{s}\text{Mpa}\geq 355 \)
Introduction:
It is a widely used cold work tool steel with high strength, good hardenability and good wear resistance, but poor impact toughness. It is mainly used for cold punching dies and punches, cold cutting scissors, drill sets, gauges, wire drawing dies, embossing dies, thread rolling plates, drawing dies and thread rolling dies, etc., which are subject to small impact loads and require high wear resistance.

Cr12 die steel is a high-carbon, high chromium steel, is also widely used in cold work die steel. The steel has good hardenability, wear resistance, hot workability. The carbides are well distributed in the steel and can be used in the manufacture of various cold work dies with complex shapes and heavy working conditions. Such as cold punching dies, thread rolling dies, wire drawing dies, material dies, metallurgical powder dies, woodworking cutting tools, cold cutting scissors drill sets and gauges and other tools. After repeated exploration and trials, we have developed a reasonable smelting process and a special ingot moulding and forging process to achieve uniformity in material organization.

Characteristics:
Vacuum degassed and refined steel; spheroidal annealed and softened for good machinability; special addition of vanadium and molybdenum strengthening elements for excellent wear resistance.

Application areas:

- 1. Thin plates up to 2MM thick, high efficiency drop dies, punch loading dies and embossing dies.
- 2. Various scissors, inlay blades, woodworking blades.
- 2. Various scissors, inlay blades, woodworking blades.

- 3. Thread rolling dies and wear resistant sliders.

- 4. Cold heading moulds, thermosetting resin moulds.

- 5. Stretch forming dies, cold extrusion dies.

### Chemical composition:

- C : 2.00 to 2.30
- Si : ≤0.40
- Mn : ≤0.40
- S : ≤0.030
- P : ≤0.030
- Cr : 11.50~13.00
- Ni: allowed residual content ≤0.25
- Cu: ≤0.30 residual content allowed
- Co: ≤1.00

### Mechanical properties:

Hardness: annealed, 269-271HB, indentation diameter 3.7-4.1mm; hardened, ≥58HRC

### Heat treatment process:

Metallographic organisation: tempered martensite + insoluble carbides + residual austenite.

### Corresponding grades:

- Chinese GB standard grades Cr12

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- Chinese GB standard grades Cr12
- German DIN standard material number 1.2080, German D1N
- German D1N standard grade x210Cr12.
- British BS standard grade BD3
- French AFN0R standard grade z200Cr12
- Italian UNI standard grade X210cr13KU/x250cr12I

**d. 3Cr13**

**Introduction:**

3Cr13 stainless steel pipe steel standard: GB/T1220-1992, is a martensitic type stainless steel, the steel machinability, after heat treatment (quenching and tempering), has excellent corrosion resistance polishing properties of high strength and wear resistance, suitable for the manufacture of high load, high wear resistance and the role of corrosive media in the plastic mold. After tempering treatment, the hardness of the 3Cr13 material below HRC30 is better machinability, easy to achieve a better surface quality. While the hardness is greater than HRC30 when the parts are processed, the surface quality is better, but the tool is easy to wear. Therefore, after the material into the factory, the first tempering treatment hardness to HRC25 ~ 30, and then cutting process.

**Chemical composition:**

- C: 0.26～0.35
- Si: ≤1.00
- Mn: ≤1.00
- S: ≤0.030
- P: ≤0.035
- Cr: 12.00～14.00
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- Cr: 12.00 – 14.00
  - Ni: ≤0.60% allowed

**Mechanical properties:**

- Tensile strength $\sigma_b$ (MPa): quenched and tempered, $\geq 735$
- Conditional yield strength $\sigma_{0.2}$ (MPa): quenched and tempered, $\geq 540$
- Elongation $\delta 5$ (%): Quenched and tempered, $\geq 12$
- Section shrinkage $\psi$ (%): quenched and tempered, $\geq 40$
- Impact power $A_{kv}$ (J): quenched and tempered,$\geq 24$
- Hardness: annealed, $\leq 235$HB; quenched and tempered 48~53HRC

**Heat treatment process:**

Heat treatment specifications: 1) annealing, $800 \sim 900$ °C slow cooling or about $750$ °C fast cooling; 2) quenching, $920 \sim 980$ °C oil cooling; 3) tempering, $600 \sim 750$ °C fast cooling.

Metallographic organisation: the organisation is characterised by martensitic type.

Delivery condition: generally delivered in heat-treated condition, the type of heat treatment is specified in the contract; if it is not specified, it is delivered in non-heat-treated condition.

**Corresponding grades:**

- US grade: 420B
- British grade: 420S45
- French grade: 730C13

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e. GCr15

Introduction:

GCr15 steel is a representative steel grade of high-carbon chromium bearing steel with good overall performance. High and uniform hardness after quenching and tempering, high wear resistance, high contact fatigue strength. Good hot workability. Good machinability after spheroidal annealing, but sensitive to the formation of white spots. Mainly used in the manufacture of internal combustion engines, electric locomotives, machine tools, tractors, rolling equipment, drilling machines, railway vehicles and mining machinery and other drive shaft steel balls, rollers and bushings.

Application areas:

Mainly used in the manufacture of internal combustion engines, electric locomotives, machine tools, tractors, steel rolling equipment, drilling machines, railway vehicles and mining machinery and other drive shaft steel balls, rollers and bushings, etc.

Chemical composition:

- C: 0.95~1.05
- Si: 0.15~0.35
- Mn: 0.25~0.45
- Cr: 1.4~1.65
- Mo: ≤0.1
- P: not more than 0.025
- S: not more than 0.025

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- O: not more than 0.025
- Ni: not more than 0.3
- Cu: not more than 0.25
- Ni+Cu: not more than 0.5

Mechanical properties:

- the impact of quenching temperature. gCr15 steel normal quenching heating temperature of 830-860 °C, more oil cooling, the best quenching heating temperature of 840 °C, after quenching the hardness of 63-65 HRC. In actual production conditions, according to the effective cross-section size of the mold and quenching medium, the quenching temperature used can vary slightly. Such as the size of larger or with nitrate salt graded quenching of the mold, it is appropriate to choose a higher quenching temperature (840-860 °C), in order to improve the hardenability, to obtain sufficient depth of the hardened layer and higher hardness; smaller size or with oil cooling of the mold generally choose a lower quenching temperature (830-850 °C). The same specifications of the mold, heating in the box furnace should be slightly higher than the heating temperature of the salt bath furnace.

- the impact of tempering temperature. As the tempering temperature rises, the hardness after tempering decreases. Tempering temperature exceeds 200 °C, will enter the first type of tempering brittle zone. Therefore, the tempering temperature of GCr15 steel is generally 160-180°C.

Heat treatment process:

1. incomplete annealing: heating 770 ~ 790 °C, heat preservation after cooling with the furnace to 550 °C below out of the furnace air-cooled, hardness requirements 187 ~ 229HBS, process characteristics Ac1 = 745 °C, Accm = 900 °C, heating temperature should be between Ac1 ~ Accm.

2. isothermal spheroid annealing: heating 770 ~ 790 °C, 680 ~ 700 °C isothermal
2. Isothermal spheroid annealing: heating 770 ~ 790 °C, 680 ~ 700 °C isothermal after cooling with the furnace to 550 °C below out of the furnace air-cooled, hardness requirements 187 ~ 229 HBS, process characteristics heating temperature should be between Ac1 ~ Accm, isothermal temperature should be lower than Ar1 = 700 °C line 20 °C, in order to obtain granular pearlite organization.

3. Stress relief annealing: heating 600 ~ 700 °C, insulation, furnace cooling, mold steel hardness requirements 187 ~ 229HBS, process characteristics to eliminate residual stress, eliminate process hardening.

4. Normalizing: heating 930 ~ 950 °C, insulation, air, hardness requirements of 302 ~ 388HBS, heating temperature higher than Accm, eliminate deviations, banding organization, mesh organization, refining grain.

5. Under the bainite isothermal quenching: heating 855 ~ 875 °C, retain 50-70min, 220-240 °C nitrate salt bath isothermal 3-4 hours, after 70-80 °C hot water rinse, hardness requirements 58 ~ 62 HRC. for large bearing parts, also need to be 260 °C tempering, insulation 2.5 hours. Isothermal quenching organization for the lower bainite + carbide + a small amount of martensite + a very small amount of residual austenite, quenching deformation is very small, high strength, good toughness.

6. Under the bainite isothermal quenching: heating 830 ~ 850 °C, 240 ~ 300 °C nitrate salt bath isothermal, after the bath air cooling, hardness requirements 58 ~ 62 HRC, Ms = 202 °C, isothermal quenching organization for the lower bainite + carbide + a small amount of martensite + a very small amount of residual austenite, quenching deformation is very small, high strength, good toughness.

7. Tempering: heating 150 ~ 190 °C, holding 2h, furnace cooling, hardness 58 ~ 62 HRC, process characteristics for the emphasis on hardness to take the lower limit, emphasis on toughness to take the upper limit.

8. Tempering: quenching heating 840 ~ 860 °C, oil-cooled, tempering heating 660 ~ 680 °C, holding after furnace cooling or air cooling, hardness requirements for 197 ~ 217 HBS, characterized by high-temperature quenching can eliminate the defects of the carbide organization, high-temperature tempering to get a fine tempered soxhlet organization, for re-quenching to do organization.
9. Solid boron penetration: Boron penetration heating 920 °C, insulation 5h, oil cooling. Infiltration agent 3% B4C + 5% KBF4 + 5% (NH2)2CO + 87% SiC hardness requirements 1500 ~ 1700HV, the surface to obtain a high hardness of the boride layer, the heart for quenching tissue, infiltration layer thickness 0.145mm.

10. Liquid chromium infiltration: heating 950 °C, heat preservation 4h, oil cooling. Infiltration agent 15% Cr2O3 + 12.5% rare earth silicon magnesium + 72.5% borax, hardness requirement 1665HV, infiltration layer thickness 0.01056mm. Improve the surface hardness, wear resistance and corrosion resistance.

11. Liquid infiltration vanadium: heating 950 °C, insulation 4h, cooling 860 °C, insulation 2h; heating 950 °C, insulation 4h, oil cooling. Infiltration agent 90% BaCl2 + 7% V2O5 + 3% Na2B4O7 + Al powder, hardness requirement 2500HV0.1, process characteristics for infiltration layer thickness 0.020mm, improve surface hardness, wear resistance.

Corresponding grades:

Chinese grades: GB/T 18254-2016

f.40Cr

Introduction:

40Cr is the standard steel grade of China GB, 40Cr steel is one of the most widely used steels in the machinery manufacturing industry. After tempering treatment has good overall mechanical properties, good low temperature impact toughness and low notch sensitivity. Steel hardenability is good, water quenching can be quenched to Ф28 ~ 60mm, oil quenching can be quenched to Ф15 ~ 40mm. This steel in addition to quenching treatment is also suitable for cyanidation and high frequency quenching treatment. Cutting performance is good, when the hardness of 174 ~ 229HB the relative cutting processability of 60%. The steel is suitable for
of 44~47HRC, the relative cutting processability of 60%. The steel is suitable for making medium-sized plastic moulds.

Application areas:

This steel is tempered and used for the manufacture of mechanical parts subjected to medium loads and working at medium speeds, such as steering knuckles and rear half-shafts of automobiles and gears, shafts, worm shafts, spline shafts, top bushings, etc. on machine tools. Quenched and tempered at medium temperature for the manufacture of parts subjected to high loads, impact and medium speed work, such as gears, spindles, oil pump rotors, sliders, rings, etc. after quenching and low-temperature tempering for the manufacture of parts subject to heavy loads, low impact and wear resistance, with solid thicknesses of 25 mm or less in the cross-section, such as worm shafts, spindles, shafts, bushings, etc. After quenching and high frequency surface hardening it is used for the manufacture of parts with high surface hardness and wear resistance without great impact, such as gears, sleeves, shafts, spindles, crankshafts, mandrels, pins, connecting rods, screws, nuts, intake valves, etc.

In addition, this steel is also suitable for the manufacture of a variety of transmission parts for carbonitriding treatment, such as large diameter and low temperature toughness of gears and shafts.

Chemical composition:

- C: 0.37~0.44
- Si: 0.17~0.37
- Mn: 0.50~0.80
- Cr: 0.80~1.10
- Ni: ≤0.030
- P: ≤0.035
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- Cu: ≤0.030
- Mo: ≤0.10

Mechanical properties:

- First quench heating temperature (°C): 850.
- Coolant: oil
- Second quench heating temperature (°C): –
- Tempering heating temperature (°C): 520.
- Tensile strength (σ b/MPa): ≥810 (at actual hardness of 25 HRC)
- Yield point (σ s/MPa): ≥785
- Elongation after break (δ 5/%): ≥9
- Section shrinkage (ψ/%) ≥45
- Impact absorbed work (Aku2/J): ≥47
- Brinell hardness (100/3000HBW) (annealed or high-temperature tempered condition): ≤207

Heat treatment process:

40Cr quenching 850°C, oil-cooled; tempering 220°C, water-cooled, oil-cooled, air-cooled. 40Cr surface quenching hardness of 52-60HRC, flame quenching can reach 48-55HRC.

Corresponding grades.

- German DIN standard material number: 1 7035/1 7045
- German DIN standard steel number: 41Cr4/42Gr4.
- British EN standard steel number: 18.
- British BS standard steel number: 41Cr4.
- French AFNOR steel grade: 42C4.
- French NF standard steel grade: 38Cr4/41Cr4.
- Italian UNI standard steel grade: 41Cr4.
- Belgian NBN standard steel grade: 42Cr4.
- Swedish SS standard steel grade: 2245.
- American AISI/SAE/ASTM standard steel number: 5140.
- Japanese JIS standard steel number: SCr440(H)/SCr440.

**g. Spring steel-65Mn**

**Introduction:**

65Mn spring steel, manganese to improve hardenability, \( \Phi 12mm \) steel can be hardened in oil, the surface decarburization tendency than silicon steel is small, the comprehensive mechanical properties after heat treatment is better than carbon steel, but there is overheating sensitivity and tempering brittleness. Used for small size of various flat, round spring, seat spring, spring barrel, also can make spring ring, valve spring, clutch reed, brake spring and cold drawn steel wire cold rolled spiral spring, etc.

**Application areas:**

- Can be used for common abrasive spring steel.
- Can be used for common abrasive spring steel
  - Cold stamping dies for convex dies
  - Can be used for plastic moulds, die-casting moulds with integral quenched top bar steel.

**Chemical composition:**

- C : 0.62 to 0.70 silicon Si : 0.17 to 0.37
- Mn : 0.90~1.20
- S : ≤0.035
- P : ≤0.035
- Cr : ≤0.25
- Ni : ≤0.30
- Cu: ≤0.25

**Mechanical properties:**

- Tensile strength σb (MPa): 825~925
- Elongation δ10 (%): 14~22.5
- Section shrinkage ψ (%): not more than 10
- Hardness: hot rolled, ≤302HB; hot rolled + heat treatment, ≤321HB

**Heat treatment process:**

Heat treatment specification and metallographic organisation.

- Heat treatment specification: quenching 830°C±20°C, oil cooled; tempering
- Heat treatment specification: quenching 850°C±20°C, oil cooled, tempering 540°C±50°C (±30°C if required for special purposes).

- Metallographic organisation: brittleness.

- Critical point temperature (approximate) Ac1=726°C, Ac3=765°C, Ar3=741°C, Ar1=689°C, Ms=270°C.

- Normalising specification: Temperature 810±10°C, air cooled. [1]

- Delivery condition: Hot rolled steel in heat treated or non-heat treated condition, cold drawn steel in heat treated condition.

h. Mould steel-SKD11

Introduction:

SKD11 tool steel is a Japanese tool steel grade, produced by Hitachi and Daido steel mills, Hitachi SKD11 commodity name SLD (the latest improved version called SLD-MAGIC), Daido steel mills commodity name DC11. both have factories in mainland China, the most well-known in the industry, the highest price. This grade is also produced domestically and the quality of the steel is comparable to that of Japanese steel, but the price is very advantageous.

Application areas:

Punching and embossing dies various scissors, inlay blades, woodworking blades thread rolling dies and wear resistant slider cold heading dies, thermosetting resin forming dies, advanced gauges and other deep drawing forming and cold extrusion dies.

Chemical composition:

- C 1.40-1.60
- Si 0.40max
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- Mn 0.60max
- Cr 11.00-13.00
- Mo 0.80-1.20
- V 0.2-0.5
- P 0.03max
- S 0.03max

Heat treatment process:

- Quenching: Preheat to 700-750°C, then heat to 1000-1050°C and cool in still air, if the thickness of the steel tool is 6” or more, heat to 980-1030°C for better hardening in oil.
- Tempering: heat to 150-200°C, stay at this temperature, then cool in still air.
- Hardness: HRC 61 or more.
- Annealing: Heat to 800-850°C, dwell at this temperature for 1 to 3 hours and allow to cool gradually in the furnace.
- Forging: 900 to 1050°C.

Corresponding grades:

- China GB Standard Grade: Cr12MoV
- China Taiwan cNS Standard Grade: SKD11
- German DIN standard material number: 1.2601
- German DIN standard grade: x165CrM0v12
- Japan Jis Standard Grade: sKD11
- Korean Ks standard grade: sTD11
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- Korean KS standard grade: SKD11
- Italian UN1 standard grade: X165CrM0W12KU
- Swedish SS Standard Grade: 2310
- UNE Standard Grade: X160CrM0V12
- American AISi/sAE Standard Grade: D3
- Russian roCT standard grade: x12M.

4. Copper alloys

a. Brass-H59

Introduction:

H59 brass is the cheapest brass, with high strength and hardness and good plasticity, still well able to withstand pressure processing in the hot state, with general corrosion resistance and other properties similar to H62.

Chemical composition:

- Zn: Residual
- Pb: ≤ 0.05
- P: ≤ 0.01 Fe
- Fe: ≤ 0.3
- Sb : ≤ 0.01
- Bi : ≤ 0.003
- Note: ≤ 1.0(impurity)
Mechanical properties:

- Tensile strength $\sigma_b$ (MPa): $\geq 294$
- Elongation $\delta_{10}$ (%): $\geq 25$

Heat treatment process:

- Hot working temperature 730 to 820°C
- Annealing temperature 600 to 670°C

b. Brass-H62

Introduction:

H62 brass, an ordinary brass with an average copper content of 62%, has good mechanical properties, good plasticity in the hot state, plasticity in the cold state is also possible, good cutting, easy to braze and weld, corrosion resistant, but prone to corrosion rupture.

Ordinary brass, with good mechanical properties, good plasticity in the hot state, plasticity in the cold state can also be, good cutting, easy brazing and welding, corrosion resistance, but easy to produce corrosion rupture. H62 (i.e. four-six brass) is widely used. At room temperature the $\beta$-phase is much harder than the $\alpha$-phase and can therefore be used for parts subjected to larger loads. $\alpha + \beta$ two-phase brass can be hot worked above 600°C. $\alpha + \beta$ two-phase brass microstructure: $\alpha$ is a bright white solid solution, $\beta$ is a CuZn-based ordered solid solution.

Application areas:

It can be used to make various deep drawing and bending manufactured stress...
It can be used to make various deep drawing and bending manufactured stress parts, such as pins, rivets, washers, nuts, conduits, barometer springs, sieves, radiator parts, etc.

**Chemical composition:**

- Cu: 60.5~63.5%
- Fe: ≤ 0.15%
- Pb: ≤ 0.08%
- Sb: ≤ 0.005%
- Bi: ≤ 0.002%
- P: ≤ 0.01%
- Zn: remainder
- Total impurities: ≤ 0.5%

**Mechanical properties:**

Room temperature tensile mechanical properties of wires other than those used for locks and clocks.

**Heat treatment process:**

- Hot working temperature 650~850°C
- Annealing temperature 600~700°C
- Low temperature annealing temperature 270-300°C for internal stress relief

c. Purple Copper-T2

Introduction
T2, short for purple copper. T2 copper refers to a copper-silver alloy in which the copper + silver elemental content of copper >99.9% is sufficient and there is no requirement for phosphorus elements. Electrical conductivity $\geq 56\text{Ms/m}$, resistance $\leq 0.0178 \times 10^{-6} \ \Omega \cdot \text{m}$.

Product characteristics: good electrical conductivity, thermal conductivity, corrosion resistance and processing properties, can be welded and brazed. Contains less conductive, thermal conductivity impurities, trace oxygen on the conductivity, thermal conductivity and processing and other performance is not significant, but easy to cause “hydrogen disease”, should not be in high temperature (such as $> 370 ^\circ \text{C}$) reducing atmosphere processing (annealing, welding, etc.) and use.

**Application areas:**

Used as a conductive, heat-conducting and corrosion-resistant material. Such as wires, cables, conductive screws, detonators for blasting, chemical evaporators, receptacles and various pipes.

**Chemical composition:**

- Copper CU (%):-
- Copper+Silver CUAG (%): $\geq 99.90$
- Tin SN (%): $\leq 0.002$
- Zinc ZN (%): $\leq 0.005$
- Lead PB (%): $\leq 0.005$
- Nickel NI (%): $\leq 0.005$
- Fe FE (%): $\leq 0.005$
- Beryllium SB (%): $\leq 0.002$
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- Beryllium Be (%): ≤0.002
- Sulphur S (%): ≤0.005
- Arsenic AS (%): ≤0.002
- Bismuth BI (%): ≤0.001
- Oxygen O (%): ≤0.06
- Others (%): ≤0.1 (impurity)
- Mechanical properties:
  - Specimen size: thickness ≥ 0.2
  - Tensile strength \( \sigma_b (\text{Mpa}) \): ≥ 195
  - Vickers hardness: ≤ 70HV

**Heat treatment process:**

Heat treatment specification: hot working temperature 900～1050℃; annealing temperature 500～700℃; recrystallisation start temperature 200～300℃ for cold work-hardened copper.

**Corresponding grades:**

Execution standard: GB/T 2059-2017

d. Oxygen-free copper TU2

**Introduction:**

TU2 oxygen-free copper has high purity, excellent electrical and thermal conductivity, no “hydrogen disease” or very little “hydrogen disease”; processing properties and welding, corrosion resistance, corrosion resistance are good. TU2 oxygen-free copper is used for electric vacuum devices and instruments and...
Oxygen-free copper is used for electric vacuum devices and instruments and meters.

**Chemical composition:**

- Cu+Ag: ≥99.95
- Tin Sn : ≤0.002
- Zinc Zn : ≤0.003
- Lead Pb: ≤0.004
- Phosphorus P: ≤0.002
- Nickel Ni: ≤0.002
- Iron Fe: ≤0.004
- Antimony Sb: ≤0.002
- Sulphur S: ≤0.004
- Arsenic As : ≤0.002
- Bismuth Bi: ≤0.001
- Oxygen O: ≤0.003
- Note: ≤0.05(impurity)

**Mechanical properties:**

Tensile strength: (σb,N/mm²)≥275

Note: Longitudinal room temperature tensile mechanical properties of bars

Specimen size: diameter 16～120
The 7 most commonly used materials for CNC machining

TU2 oxygen-free copper is 99.95% pure, with an oxygen content of no more than 0.003% and a total impurity content of no more than 0.05%. The molecular formula is Cu.

The main characteristic of TU2 oxygen-free copper is that the oxygen content of this standard substance is fixed at no more than 10 ppm, the fixed value of the example is 3.0±0.7 ppm.

**Corresponding grade:**

GB/T 5231-2001

e. Tin bronze-QSn-6-6-3

**Introduction:**

Tin bronze has high wear resistance and elasticity, good anti-magnetic properties, withstands hot or cold pressure work well; in the hard state, good machinability, easy to weld and braze, good corrosion resistance in atmosphere, fresh and sea water.

**Application areas:**

- 1, used to make springs (flat springs, round springs) and other elastic components.
- 2, chemical equipment on the corrosion-resistant parts and wear-resistant parts (such as bushings, discs, bearings, etc.)
- 3, anti-magnetic parts paper industry with scrapers.
- 4, for wear-resistant parts under high load and high-speed work, such as connecting rods, bushings, bushings, gears and other wear-resistant mechanical parts.

**Chemical composition:**

https://www.injectionmoldingcnc.com/articles/cnc-machining-materials/
Chemical composition:

- Sn: 7.0-9.0
- P: 0.03-0.35
- Zn: ≤0.20
- Ni: ≤0.20
- Fe: ≤0.01
- Pb: ≤0.05
- Cu: remainder

Mechanical properties:

- Tensile strength $\sigma_b$ (MPa): $\geq 350$
- Elongation $\delta_{10}$ (%): $\geq 55$

Note: Longitudinal room temperature tensile mechanical properties of bars

- Specimen size: diameter or distance between opposite sides 40 to 120

Corresponding grade:

GB/T 5231-2001

f. Beryllium Copper-C17200

Introduction:

C17200 beryllium copper is a kind of imported beryllium copper, the whole series of beryllium copper is called “the king of non-ferrous metal elasticity”, used in all kinds of micro-motor brushes, switches, relays, connectors, temperature controllers, all kinds of spring pieces which require high strength, high elasticity, high hardness and high wear resistance. The demand for beryllium copper will be...
Beryllium copper alloy has excellent mechanical properties, physical properties and chemical properties in one, after heat treatment (solution treatment and aging treatment), it has high strength limit, elastic limit, yield limit and fatigue limit which are comparable with special steel, and also has high electrical conductivity, thermal conductivity, high hardness, corrosion resistance, wear resistance, good casting performance, non-magnetic and non-sparking characteristics, which are widely used in mould making, machinery, electronics and other industries. It is widely used in mould making, machinery, electronics and other industries.

No grit, no porosity, balanced hardness, dense structure, high strength, good thermal conductivity, good electrical conductivity, corrosion resistance, excellent wear resistance, good processing properties, stable performance under high pressure, non-magnetic, excellent polishing properties, good anti-adhesive properties.

**Application areas:**

Injection moulds and high pressure blow moulds, mould inserts, fast cooling, aluminium alloy mould inserts, increase strength, wear resistance and shorten injection cycle, hot runner nozzles, electrode and punch materials, non-magnetic moulds, non-magnetic tools, high thermal conductivity bearings, mirror surface with high surface accuracy.

The commonly used beryllium copper grades are as follows

C17200 / C17300 / C17000 are high strength deformation alloys.

C17500 / C17510 for high conductivity deformation alloy.
BeA-10C / BeA-50C are highly conductive casting alloys.

**Chemical composition:**

- Beryllium Be: 1.90-2.15
- Cobalt Co: 0.35-0.65
- Nickel Ni: 0.20-0.25
- Cu: remainder
- Silicon Si: <0.15
- Iron Fe: <0.15
- Aluminium Al: <0.15
- Comparative standard: AISI C17200

**Mechanical properties:**

- Tensile strength (Mpa): 1105
- Specific gravity (g/cm³): 8.3
- Yield strength (0.2%) Mpa: 1035
- Softening temperature (°C): 930
- Elongation (%): 1
- Modulus of elasticity (Gpa): 128
- Hardness (HRC): 38-44
- Thermal conductivity (W/m.k 20°C): 105
- Electrical conductivity (IACS%): 18
5、Aluminium alloy material

a. Electrotechnical pure iron - DT4C

Introduction:

Electrotechnically pure iron is also known as industrial pure iron. It is a high quality steel with an iron content of 99.5% or more. It is a low carbon, low sulphur, low phosphorus iron.

The concepts that need to be distinguished are:

One, pure iron: that is, steel containing nearly 100% iron, a very soft and soft metal.

Two, pig iron: the carbon content is 3.5%-5.5%.

Three, industrial pure iron: the chemical composition is mainly iron, the content of 99.50%-99.90%, the amount of carbon in iron is below 0.04%.

Four, steel: the generic name for all iron and iron alloys, the normal carbon content are larger. According to the carbon content, can be divided into high carbon steel, medium carbon steel, low carbon steel.

As can be seen from the above, the difference between pure iron, pig iron and steel lies mainly in the difference in the carbon content of the iron.

Industrial pure iron is a kind of steel, its chemical composition is mainly iron, the carbon content is below 0.04%, the less other elements the better. Because it is not really pure iron, it is called industrial pure iron, a steel that is close to pure iron.
Commonly used electrical pure iron are DT4, DT4A, DT4E, DT4C, DT8, DT8A, DT8E, DT8C pure iron.

Usually marketed as pure iron strip, pure iron coil, pure iron plate, pure iron bar, pure iron round bar, all refer to industrial pure iron.

**Application areas:**

Industrial pure iron is mainly used for electromagnetic relays, pure iron for iron cores, soft magnetic pure iron, pure iron for magnetic powder clutches, pure iron for electronic locks, electric pure iron for automotive pistons, pure iron strip for magnetic shielding, pure iron for aviation instruments, military pure iron, pure iron for galvanized pans in thick sheets, pure iron for electronic components in thin sheets, solenoid valves, pure iron for magnetic separators, pure iron without hairline, pure iron for electronic tubes, easy to turn electric pure iron.

**Chemical composition:**

- C: 0.025
- Si: 0.20
- Mn: 0.30 0.020 0.020
- Al: 0.15～0.50
- Cr: 0.10
- Ni: 0.20
- Cu: 0.20

**Mechanical properties:**

Generally industrial pure iron is exceptionally soft and ductile, with excellent...
Generally, industrial pure iron is exceptionally soft and ductile, with excellent electromagnetic properties.

Industrial pure iron has a higher melting point than iron, is harder to rust than iron in humid air and can be passivated in cold concentrated sulphuric acid.

- 1) Good electromagnetic properties. Low coercive force \( (H_c) \), high permeability \( \mu \), high saturation magnetic susceptibility \( (B_s) \), magnetic stability and no magnetic ageing.

- 2) High purity of steel. Electromagnetism pure iron series steel quality are sedimentation steel, and the use of refining, so the internal organization is dense, uniform, excellent, less gas content, the finished product contains \( \leq 0.004\% \) carbon, which simplifies and shortens the user parts annealing process to create a reliable condition.

- 3) Cold and hot processing performance is good. Cold processing such as turning, pier, punching, bending, pulling ...... etc. are no problem. Hot processing, such as re-forging, re-rolling process, red brittle sensitivity is small, many grades without red brittle area, can ensure that the processing in a wide range of temperatures.

- 4) Good surface quality. With good welding and plating performance.

- 5) High dimensional accuracy. Super precision cold-rolled plate can be provided, such as plate thickness \( \leq 105\text{mm} \), thickness tolerance can be guaranteed \( \leq 0.03\text{mm} \); plate thickness \( > 1.5\text{mm} \), thickness tolerance can be guaranteed \( \leq \pm 0.05\text{mm} \).

b. Titanium alloy-TC4

Introduction:

Titanium alloy TC4 has the advantages of good corrosion resistance, strong plastic deformation capacity, high specific strength, good oxidation resistance below 550°C, and relatively strong passivation capacity, etc. It has been used in a large number of industries such as aerospace mechanical structures and chemical.
Number of industries such as aerospace mechanical structures and chemical industry. However, as an important structural component of the material, titanium alloy TC4 has its own disadvantages: the surface is easy to scratch, bite, wear resistance is poor, and lack of high temperature corrosion resistance. To this end, this paper investigates the method of iron plating on the surface of titanium alloy TC4 to overcome the material defects of titanium alloy TC4 and to improve the mechanical properties and high temperature performance of the material surface.

**Application areas:**

It is successfully used in aerospace, petrochemical, shipbuilding, automotive, pharmaceutical and other sectors.

**Chemical composition:**

- TC4 with titanium (Ti) balance,
- Iron(Fe) ≤ 0.30,
- Carbon(C) ≤ 0.10,
- Nitrogen(N) ≤ 0.05,
- Hydrogen(H) ≤ 0.015,
- Oxygen(O) ≤ 0.20,
- Aluminium (Al) 5.5-6.8,
- Vanadium(V) 3.5-4.5

**c. Magnesium alloy-AZ91D**

**Introduction:**

AZ91D belongs to the category of cast magnesium alloys, mainly relying on
AZ91D belongs to the category of cast magnesium alloys, mainly relying on pressure mould casting supplemented by later processing, the appearance can be changed by surface methods such as electrophoresis. A stands for aluminium metal Al, Z stands for zinc metal Zn, 9 stands for aluminium content of 9%, 1 stands for zinc content of 1%, the last D is the identification code. (Chinese Standard GB/T5153-2003)

**Chemical composition:**

- Mg: remainder
- Al: 8.5-9.5
- Zn: 0.45-0.90
- Mn: 0.17-0.4
- Si: <=0.05
- Cu: <=0.025
- Ni: <=0.001
- Fe: <=0.004

6. Plastic

a. Engineering plastics-ABS

**Introduction:**

ABS engineering plastics that PC + ABS (engineering plastics alloy), in the chemical industry, the Chinese name for the plastic alloy, the reason for the name PC + ABS, because this material has PC resin excellent heat and weather resistance, dimensional stability and impact resistance, but also has ABS resin excellent processing fluidity. The biggest drawback of ABS engineering plastics is their heavy mass and poor thermal conductivity. Its moulding temperature is...
the 7 most commonly used materials for cnc machining

their heavy mass and poor thermal conductivity. Its molding temperature is taken from the temperature between the two raw materials, which is 240-265 degrees, too high for ABS to decompose and too low for PC material to flow well.

Application areas:

The largest areas of application for ABS resins are automotive, electronic and electrical appliances and building materials. In the automotive sector, it is used in dashboards, exterior body panels, interior trim panels, steering wheels, acoustic panels, door locks, bumpers, ventilation ducts and many other components. In electrical appliances, ABS is widely used in refrigerators, televisions, washing machines, air conditioners, computers, photocopiers and other electronic appliances. For building materials, ABS pipes, ABS sanitary ware and ABS decorative panels are widely used in the building materials industry. ABS is also widely used in packaging, furniture, sporting and recreational goods, machinery and instrumentation industries.

Chemical composition:

Performance.

1. General performance

ABS engineering plastic is opaque and ivory-colored granules, and its products can be colorful and have high gloss.

2. Mechanical properties

ABS has excellent mechanical properties, its impact strength is excellent and can be used at very low temperatures: ABS has excellent wear resistance, good dimensional stability and oil resistance, and can be used for bearings under medium loads and rotational speeds. The mechanical properties of ABS are influenced by temperature.
3. Thermal properties

The thermal deformation temperature of ABS is 93~118°C. The product can be increased by about 10°C after annealing treatment.

4. Electrical properties

ABS has good electrical insulation and is virtually unaffected by temperature, humidity and frequency, and can be used in most environments.

5. Environmental performance

ABS is unaffected by water, inorganic salts, alkalis and acids, but is soluble in ketones, aldehydes and chlorinated hydrocarbons, and is subject to stress cracking by ice acetic acid and vegetable oils.

b. Polytetrafluoroethylene—PTFE

**Introduction:**

Poly tetra fluoroethylene (PTFE), commonly known as “King of Plastics”, is a polymer made by polymerising tetrafluoroethylene as a monomer. It is white and waxy, translucent, with excellent heat and cold resistance, and can be used for a long time at -180 to 260ºC. This material is resistant to acids and bases and to various organic solvents and is insoluble in almost all solvents. Teflon is also resistant to high temperatures and has an extremely low coefficient of friction, making it an ideal coating for the interior of easy-to-clean water pipes, as well as for lubrication.

**Application areas:**

- 1. Used in the electrical industry, in aerospace, aviation, electronics, instrumentation, computers and other industries as an insulating layer for power and signal lines, corrosion-resistant, wear-resistant materials can be
2. used in electrical, chemical, aviation, machinery and other fields instead of quartz glassware used in atomic energy, medicine, semiconductor and other industries for ultra-pure chemical analysis and storage of various acids, alkalis, organic solvents can be made into highly insulating electrical parts, high-frequency wire and cable coverings, corrosion-resistant chemical vessels, alpine-resistant oil pipelines, artificial organs, etc. can be used as plastics, rubber, coatings, inks, lubricants, greases, etc. Additive.

3. This product is resistant to high temperature and corrosion, has excellent electrical insulation, aging resistance, low water absorption, excellent self-lubricating properties, is a general-purpose lubricating powder for various media, can be quickly applied to form a dry film, to be used as a substitute for graphite, molybdenum and other inorganic lubricants. Suitable as a release agent for thermoplastic and thermosetting polymers with excellent load-bearing capacity. Widely used in the elastomer and rubber industries as well as in corrosion protection.

4. Used as a filler for epoxy resins to improve the wear resistance, heat resistance and corrosion resistance of epoxy adhesives.

5. Mainly used as a binder and filler for powder cakes.

Properties and stability.

1. stable at room temperature and pressure, avoid moisture, heat and high temperature
   No real melting point, decomposes slowly above 450°C and changes directly into a gas. At 327°C, mechanical strength suddenly disappears. Insoluble in any solvent. It is not attacked by any substance except molten alkali metals and does not change even when boiled in hydrofluoric acid, aqua regia or fuming sulphuric acid or sodium hydroxide.

2. white, odourless, tasteless, non-toxic powder, commonly known as “Plastic
2. White, odourless, tasteless, non-toxic powder, commonly known as “Plastic King”. It has excellent chemical stability, corrosion resistance, sealing, high lubrication and non-stick, electrical insulation and good anti-aging resistance. High temperature resistance, working temperature up to 250°C. Low temperature resistance, good mechanical toughness at low temperatures, even if the temperature drops to -196°C, it can maintain 5% elongation. Corrosion resistance, to most chemicals and solvents show inert, can resist strong acid strong alkali, water and a variety of organic solvents. Good weather resistance, has the best ageing life of any plastic. Highly lubricious, with the lowest coefficient of friction of any solid material. Non-adhesive, has the lowest surface tension of any solid material and does not adhere to any substance. Non-toxic, physiologically inert, no adverse reactions to long-term implantation as artificial blood vessels and organs.

c. Cyclosteel-POM

Introduction:

Also known as polyoxymethylene. The structure is, abbreviated as POM, usually the polymer of formaldehyde polymerization, polymerization degree is not high, and easy to heat depolymerization. 1955 before and after the DuPont company from formaldehyde polymerization to get formaldehyde homopolymer. Formaldehyde is very easy to crystallize, crystallization degree of 70% or more. The melting temperature of homopolymerised formaldehyde is about 180°C.

Industrial applications

POM has a very low coefficient of friction and very good geometrical stability, making it particularly suitable for making gears and bearings. Because it is also resistant to high temperatures, it is also used in piping devices (valves, pump housings), lawn equipment, etc.

Civil application areas

Audio equipment such as VCRs, CDs, LDs, MD players, radios, headphones.
Audio equipment such as VCRs, CDs, LDs, MD players, radios, headphones, stereos, OA equipment such as printers, keyboards, CD-ROM drives, household appliances such as washing machines, dryers, hairdryers, parts for automobiles such as seat belt mechanics, external door handles, mirrors, engine chambers, precision parts for cameras, clocks, etc., as well as construction materials, toys such as game consoles and stationery. The materials used for moulding toys and stationery, etc.

**Performance parameters:**

- Density 1.45g/cm³ Volume resistance VD0303 ≥1015xcm
- Water absorption 0.8% Surface resistance VDE0303 ≥1013
- Chemical resistance – Dielectric constant 1MHz DIN53483 3.8
- Continuous use temperature -50~ 90°C Dielectric loss factor 1MHz DIN53483 0.005
- Yield tensile strength 62MPa Dielectric strength VDE0303 85kv/mm
- Yield tensile strain 10% Leakage current strength DIN5340 KC600
- Ultimate tensile strength – Adhesion
- Ultimate tensile strain 40% Non-toxic and non-hazardous EEC 90/128 +
- Impact toughness 0.8kJ/m² Friction coefficient DIN53375 0.35
- Notched impact toughness 7kJ/m² Flammability UL94 HB
- Rockwell ball hardness 135MPa UV resistance U.V 0
- Shore D hardness 85 Acid resistance `
- Flexural strength – alkali resistance
- Modulus of elasticity 2600MPa Water carbonate resistance
- Vicat softening temperature 150°C Carbonic acid and water resistance (CKW) 0

- Thermal distortion temperature – Resistance to aromatic compounds
- Thermal linear expansion coefficient 1.1k-1*104 Ketone resistance

- Thermal conductivity 20°C 0.31w/(mxk) Thermal water resistance

Injection moulding process:

- Drying treatment: if the material is stored in a dry environment, drying treatment is usually not required.

- Melting temperature: 190~230°C for homopolymer materials; 190~210°C for copolymer materials.

- Mould temperature: 80~105°C. A higher mould temperature can be used to reduce shrinkage after moulding. Injection pressure: 700~1200 bar.

- Injection speed: Medium to fast, too slow to produce ripples, too fast to produce shot lines and shear overheating.

- Runners and gates: Any type of gate can be used. If a tunnel shaped gate is used, a shorter type is preferable. For homopolymer materials it is recommended to use a hot

- Nozzle runners. For copolymer materials both internal and external hot runners can be used.

- Back pressure: the lower the better, generally no more than 200 bar

- Retention time: POM-H can be retained at 215°C for 35 minutes if the equipment does not have a melt retention point; POM-K can be retained at 205°C for 20 minutes without serious decomposition.

- The melt cannot be held in the barrel for more than 20 minutes at injection temperature. If the machine is shut down, the barrel temperature can be reduced to 150°C. If the machine is shut down for a long time, the barrel must be cleaned and the heater switched off.

- Shutdown: The barrel must be cleaned with PE or PP, the electric heater switched off and the screw pushed in the forward position. The barrel and screw must be kept clean. Impurities or dirt can change the superheat stability of POM (especially POM-H). So when finished with halogenated polymers or other acidic polymers, they should be cleaned up with PE before heating POM.
other acidic polymers, they should be cleaned up with PE before beating POM material, otherwise an explosion can occur. If improperly acting pigments, lubricants or materials containing GF nylon can lead to degradation of the plastic.

- Post-treatment: For very warm use of the parts and high quality requirements, heat treatment must be carried out.

- The effect of the annealing treatment can be checked by immersing the product in a 30% hydrochloric acid solution for 30 minutes and then judging with the naked eye whether residual stress cracks are produced.

d. Bakelite

Introduction:

Bakelite is the first variety of plastic to be put into industrial production, the chemical name of Bakelite is phenolic plastic, it has high mechanical strength, good insulation, heat resistance, corrosion resistance, so it is often used in the manufacture of electrical materials, such as switches, lamp heads, headphones, telephone cases, instrument cases, etc., “Bakelite” thus named.

Application areas:

Bakelite has been used in many areas of our lives, such as: bakelite sockets, bakelite switches, bakelite spoon handles, bakelite gourd wire, bakelite records, bakelite handwheels, handles, knobs, pulls, tissue boxes, kitchen stove board tables, bakelite tea trays, balls for billiards and many more.

e. Plexiglass-PMMA

Introduction:

Plexiglass (Polymethyl methacrylate) is the common name for a polymeric.
Plexiglass (Poly(methyl methacrylate)) is the common name for a polymeric transparent material called polymethyl methacrylate, which is a polymeric compound made from the polymerisation of methyl methacrylate. It is an important thermoplastic that was developed earlier. Plexiglass is divided into four types of colourless transparent, coloured transparent, pearlescent and embossed plexiglass. Plexiglass is commonly known as acrylic, C.X. acrylic, sub-gloss, plexiglass has better transparency, chemical stability, mechanical properties and weather resistance, easy to dye, easy processing, beautiful appearance and other advantages. Plexiglass is also called gelatin glass, acrylic, etc.

**Application areas:**

Plexiglass is widely used, not only in commerce, light industry, construction and chemical industry. And plexiglass production, in advertising decoration, sand model is very widely used, such as: signage, billboards, light box panels and Chinese and English letter panels.

The selection of materials depends on the modelling design, what kind of modelling, what kind of plexiglass, colour and variety should be tested repeatedly to make the best effect. With a good modelling design, but also rely on careful processing and production, in order to become a beautiful craft.

- 1. Architectural applications: windows, soundproof doors and windows, light covers, telephone booths, etc.
- 2. Advertising applications: light boxes, signboards, signage, exhibition stands, etc.
- 3. Traffic applications: trains, cars and other vehicles, doors and windows, etc.
- 4. Medical applications: baby incubators, various surgical medical instruments
  Civilian products: bathroom facilities, handicrafts, cosmetics, brackets, aquariums, etc.
- 5. Industrial applications: instrument surface panels and covers, etc.

- 6. Lighting applications: fluorescent lamps, chandeliers, street lamp shades
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- 6. Lighting applications: fluorescent lamps, chandeliers, street lamp shades, etc.

- 7. Household applications: fruit plates, tissue boxes, acrylic art paintings and other daily household products

**Characteristics:**

Polymethyl methacrylate is often referred to as Plexiglas, abbreviated PMMA, which has the advantages of high transparency, low price and easy machining, and is often used as an alternative to glass. Plexiglass is an important thermoplastic that has been developed earlier, with transparency, stability and weather resistance, easy to dye, easy to process, beautiful appearance, and has a wide range of applications in the construction industry.

- **①** Highly transparent. Plexiglass is an excellent polymer transparent material with a light transmission rate of 92%, which is higher than that of glass. The lamp of the sun lamp, known as the artificial small sun, is made of quartz, because quartz can completely transmit ultraviolet light. Ordinary glass can only transmit 0.6% of ultraviolet light, but plexiglass can transmit 73%.

- **②** High mechanical strength. The relative molecular mass of plexiglass is about 2 million, which is a long-chain polymer compound, and the chain forming the molecule is very soft, therefore, the strength of plexiglass is relatively high, and the resistance to stretching and impact is 7-18 times higher than ordinary glass. There is a type of Plexiglas that has been heated and stretched, in which the molecular chain segments are arranged in a very orderly manner, giving the material a significant increase in toughness. When a nail is driven into this plexiglass, no cracks are produced in the plexiglass even if the nail penetrates. The plexiglass also does not break into pieces when pierced by a bullet. Therefore, stretching treatment of plexiglass can be used as bulletproof glass, but also used as the cockpit cover on military aircraft.

- **③** Light weight. The density of plexiglass is 1.18g/cm³; the same size of the material, its weight is only half of ordinary glass, metal aluminum (a light metal) of 43%.

- **④** Easy to process. Plexiglass can not only be cut by lathe, drilling machine for
Easy to process. Plexiglass can not only be cut by lathe, drilling machine for drilling, and can be bonded with acetone, chloroform, etc. into a variety of shapes of apparatus, but also blow molding, injection, extrusion and other plastic molding methods into large aircraft cockpit cover, small to dentures and dental brackets and other products of all shapes and sizes.

Advantages:

1. The beauty of plexiglass: mirror effect, exquisite craftsmanship, no folds, no seams.
2. the visual effect of plexiglass: a variety of colours, visual impact is very strong.
3. the light transmission of plexiglass: light transmission rate can reach 96%, excellent light transmission rate, soft light.
4. the impact resistance of plexiglass: more than 200 times that of ordinary glass products, almost without any risk of fracture.
5. the durability of plexiglass: the product has very good protection for the built-in light source, extending the life of the light source products.
6. the weather resistance of plexiglass: can ensure a long period of time does not fade, the use of good quality plate up to 6-13 years of long.
7. the flame-resistance of plexiglass: there will be no spontaneous combustion and with self-extinguishing.
8. the energy efficiency of plexiglass: light transmission is very good, relatively reduce the light source, save electricity and reduce the cost of use.
9. the reasonableness of the plexiglass: reasonable design and rainproof and moisture-proof, open structure, easy to clean and maintain, etc.

Electrical properties

Polymethyl methacrylate has less electrical properties than non-polar plastics such as polyolefins and polystyrene due to the presence of polar methyl ester groups in the side positions of the main chain. The polarity of the methyl ester
groups in the side positions of the main chain. The polarity of the methyl ester group is not too great and polymethyl methacrylate still has good dielectric and electrical insulation properties. It is worth pointing out that polymethyl methacrylate, and indeed acrylic plastics in general, have excellent resistance to arcing, with no carbonised conductive pathways or arc traces on the surface under arcing. 20°C is a secondary transition temperature, corresponding to the temperature at which the lateral methyl ester group starts to move, below 20°C the lateral methyl ester group is in a frozen state and the electrical properties of the material are improved compared to when it is above 20°C. The electrical properties of the material are improved compared to above 20°C.

Physical properties

Polymethyl methacrylate has good overall mechanical properties, in the forefront of general-purpose plastics, tensile, bending, compression and other strength are higher than polyolefin, but also higher than polystyrene, polyvinyl chloride, etc., impact toughness is poor, but also slightly better than polystyrene. The mechanical properties in tensile, bending and compression are somewhat higher in cast polymeric polymethyl methacrylate sheets (e.g. plexiglass sheets for aviation), which can reach the level of engineering plastics such as polyamide and polycarbonate.

Generally speaking, the tensile strength of polymethyl methacrylate can reach the level of 50-77 MPa and the bending strength can reach 90-130 MPa, the upper limit of these performance data has reached or even exceeded some engineering plastics. The elongation at break is only 2%-3%, so the mechanical properties of the plastic is basically hard and brittle, and has a gap sensitivity, easy to crack under stress, but the fracture is not as sharp and uneven as polystyrene and ordinary inorganic glass. 40 °C is a secondary transformation temperature, equivalent to the temperature at which the side methyl starts to move, more than 40 °C, the toughness of the material, ductility has improved. The surface hardness of polymethyl methacrylate is low and can be easily scratched.

The strength of polymethyl methacrylate is related to the time of stress, and decreases with increasing time. The mechanical properties of polymethyl methacrylate (oriented plexiglass) have been significantly improved after tensile.
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Methacrylate (oriented plexiglass) have been significantly improved after tension orientation and the notch sensitivity has been improved.

The heat resistance of polymethyl methacrylate is not high, although its glass transition temperature reaches 104°C, the maximum continuous use temperature varies with the working conditions between 65°C and 95°C. The heat deflection temperature is about 96°C (1.18 MPa) and the Vicat softening point is about 113°C. Heat resistance can be improved by copolymerisation of the monomer with acrylate methacrylate or glycol bis-ester acrylate. Polymethyl methacrylate is also poorly resistant to cold, with a brittleness temperature of about 9.2°C. The thermal stability of polymethyl methacrylate is medium, better than polyvinyl chloride and polyformaldehyde, but not as good as polyolefins and polystyrene, thermal decomposition temperature is slightly higher than 270°C, its flow temperature is about 160°C, so there is still a wide range of melt processing temperature.

The thermal conductivity and specific heat capacity of polymethyl methacrylate are medium in plastics, 0.19W/M.K and 1464J/Kg.K respectively.

Chemical properties

Chemical and solvent resistance

Polymethyl methacrylate is resistant to dilute inorganic acids, but concentrated inorganic acids can make it erode, resistant to alkalis, but warm sodium hydroxide and potassium hydroxide can make it leach, resistant to salts and oils, resistant to aliphatic hydrocarbons, insoluble in water, methanol, glycerin, etc., but can absorb alcohol swelling and produce stress cracking, not resistant to ketones, chlorinated hydrocarbons and aromatics. It has a solubility parameter of about 18.8 (J/CM3)1/2, and is soluble in many chlorinated and aromatic hydrocarbons, such as dichloroethane, trichloroethylene, chloroform, toluene, etc. Vinyl acetate and acetone can also make it soluble.

Polymethyl methacrylate has good resistance to gases such as ozone and sulphur dioxide.

Weather resistance

https://www.injectionmoldingcnc.com/articles/cnc-machining-materials/
Weather resistance

Polymethyl methacrylate has excellent resistance to atmospheric ageing. Its specimens have been subjected to natural ageing tests for 4 years, with changes in weight, a slight decrease in tensile strength and light transmission, a slight yellowing of colour, a more pronounced decrease in resistance to silver streaks, and a slight increase in impact strength, while other physical properties remain almost unchanged.

Flammability

Polymethyl methacrylate is very flammable, with an ultimate oxygen index of 17.3.

f. Polypropylene-PP

Introduction:

Polypropylene, abbreviated as PP, is a colourless, odourless, non-toxic, semi-transparent solid substance. Polypropylene is a thermoplastic synthetic resin with excellent properties and is a colourless and translucent thermoplastic light general purpose plastic. It has chemical resistance, heat resistance, electrical insulation, high strength mechanical properties and good high wear resistance processing properties, which makes polypropylene since its introduction, it has been rapidly developed and applied in many fields such as machinery, automobiles, electronics and electrical appliances, construction, textiles, packaging, agriculture, forestry, fishery and food industry. In recent years, the rapid development of packaging, electronics and automotive industries in China has greatly contributed to the development of our industry. And because of its plasticity, polypropylene materials are gradually replacing wooden products, and high strength toughness and high wear resistance have gradually replaced the mechanical functions of metal. In addition, polypropylene has good grafting and compounding capabilities and has great scope for application in concrete, textiles, packaging and agriculture, forestry and fisheries.
Distribution of uses

European and American countries for injection molding products accounted for 50% of the total consumption, mainly used as parts of cars, electrical appliances, various containers, furniture, packaging materials and medical equipment, etc.; film accounted for 8% to 15%, polypropylene fiber (China used to be called polypropylene) accounted for 8% to 10%; construction and other tubes and plates accounted for 10% to 15%, the other 10% to 12%. China currently uses 40% to 45% of the volume for woven products, followed by about 40% for films and injection products; polypropylene and others account for 10% to 20%.

China mainly uses polypropylene as a material in food packaging, household items, automobiles, fibre optics and other applications. The largest areas in which polypropylene is used in China are woven bags, packaging bags, bundling ropes and other products, accounting for about 30% of total consumption. In recent years, with the development of polypropylene injection moulded products and packaging films, the proportion of polypropylene used in woven products has declined, but it is still the region with the highest consumption of its polypropylene. Injection moulded products are the second largest area of polypropylene consumption in China, accounting for around 26% of total consumption, and it is also one of the regions with the highest future demand for polypropylene. Another major consumption area for domestic polypropylene is film, which accounts for around 20% of total consumption, mainly BOPP (bi-oriented polypropylene film). In the coming years, the proportion of textile products will gradually decline, while the proportion of injection moulded products, pipes and sheets will increase. According to expert forecasts for the development of the polypropylene industry, demand for polypropylene in China is likely to reach around 23.7 million tonnes by 2020. Textile products, injection moulded products and films are still the main areas of demand for polypropylene in China, while the annual demand for pipes, sheets and fibres is growing rapidly and domestic demand for polypropylene is growing rapidly. The market for special materials such as high-speed drawing BOPP films, pipes, thin non-woven fabrics and highly transparent food containers has good prospects for development.
Polypropylene has good mechanical properties and can be manufactured directly or modified to make parts for various machinery and equipment, such as industrial pipes, agricultural water pipes, motor fans, infrastructure formwork, etc. Modified polypropylene can be moulded into bumpers, scuff bars, steering wheels, dashboards and interior decorative parts, which greatly reduce the weight of the body to achieve the purpose of energy saving.

**Electronic and electrical industry components**

Modified polypropylene is used to make insulating shells for household appliances and washing machine liners, and is commonly used as insulation for wires and cables and other electrical appliances. The polypropylene composites made from 60-80 parts by weight of homopolymerised polypropylene, 20-40 parts by weight of ethylene vinyl alcohol copolymer, 1-10 parts by weight of compatibiliser (polypropylene maleic anhydride graft and ethylene vinyl alcohol copolymer reactant), are mixed at 170°C to 190°C. The polypropylene composites have high toughness, with an impact strength of 210 J/m, high gas barrier properties, and a permeability to water vapour rate is close to 2000 g- μ m/(m²-24h). In the preparation of barrier films, they can be produced using the traditional film-making process, which is relatively simple and produces at a low cost.

**Construction industry**

Polypropylene fibres are the lightest of all chemical fibres, with a density of (0.90-0.92) g/cm³, high strength, good toughness, good chemical resistance and antimicrobial properties and low prices. Polypropylene modified with glass fibre reinforcement or modified with rubber or SBS is used in large quantities to make templates for construction work. In the event of an earthquake, the form of damage to the polypropylene fibre ceramic concrete is plastic damage, without spalling of fragments. The choice of polypropylene fibre pellet concrete is safer than plain pellet concrete.

**Agriculture, fishing and food industry**

Polypropylene can be used to make greenhouse awnings, mulch, culture bottles, etc.
Polypropylene can be used to make greenhouse awnings, mulch, culture bottles, agricultural tools, fish nets, etc., food crates, food bags, beverage packaging bottles, etc. Multifunctional waste PET is made by reactive blending with waste PET (polyethylene terephthalate), and in-situ fibre-forming composites are made by laminating multifunctional waste PET with polypropylene in-situ. The composites have structural characteristics such as the formation of shaped microfibres from waste PET and the formation of a moderately flexible and strong bonding interface between the waste PET microfibres and the PP matrix resin. The toughness and rigidity of the in-situ fibre-forming composites prepared from the composite of waste PET and PP are significantly higher than those of PP, and the reproducibility of the mechanical properties is quite good. It has significant economic and social benefits to resource the large amount of waste, i.e. waste PET, produced in China every year.

The eastern coastal region of China, with its vast marine mudflats, has typical saline soil characteristics. There is a study on polyacrylamide (PAM) in collaboration with three species of forage grasses to implement soil and water conservation in coastal saline soil areas. The application of PAM under biological measures has a good contribution to the improvement of soil erosion resistance of all three forage grasses. Application of PAM reduced soil erosion and enhanced rainwater retention; priority was given to low doses (1g/m), which had the highest soil and water conservation benefits per unit mass of PAM, reducing annual erosion by 42.8% to 46.7%, inhibiting total soil take-up by 28.7% to 40.4%, increasing soil water dissipation by 5.0% to 12.4%, reducing water dissipation rate by 1.83% to 3.25% and promote the rise of soil water holding capacity; in the early stage of forage growth. The synergistic effect of PAM helps to inhibit the production of soil water loss and enhance the retention capacity of rainwater.

**Textile and printing industry**

Polypropylene is a raw material for synthetic fibres. Polypropylene fibres are widely used to make lightweight, beautiful and durable textile products, and the images printed with polypropylene materials are particularly bright, vibrant and beautiful.

**Other industries**

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In the chemical industry, polypropylene is used in the preparation of corrosion-resistant transport pipes, tanks, valves, profiled fillers in filler towers, filter cloths, lining of corrosion-resistant pumps and corrosion-resistant containers; in medicine, it is used to make medical instruments; and in energy applications through grafting, compounding and blending processes.

g. Polyphenylene sulfide-PPS

Introduction:

PPS is a comprehensive performance of special engineering plastics, PPS has excellent high temperature resistance, corrosion resistance, radiation resistance, flame retardant, balanced physical and mechanical properties and excellent dimensional stability and excellent electrical properties, etc., is widely used as a structural polymer materials, through the filling, modified widely used as special engineering plastics. At the same time, it can also be made into various functional films, coatings and composites, which have been successfully applied in the fields of electronics and electrical appliances, aerospace, automotive transportation, etc.

Application areas:

Electronics: high voltage components, housings, sockets and terminals on televisions and computers, starting coils and blades of electric motors, brush brackets and rotor insulation parts, contact switches, relays, irons, hair dryers, lamp heads, heaters, F-grade films, etc.

Automotive industry: for exhaust recirculation valves and water pump impellers, and carburetors, exhaust devices, exhaust control valves, light reflectors, bearings, sensing components, etc.
Mechanical industry: used as bearings, pumps, valves, pistons, precision gears, as well as copiers, cameras, computer parts, conduits, sprayers, oil injectors, instrumentation parts, etc.

Chemical industry: used to make acid and alkali resistant valves pipes, fittings, valves, gaskets and submersible pumps or impellers and other corrosion resistant parts.

Engineering plastics: manufacture of automotive parts, anti-corrosion coatings, electrical insulation materials, etc.

Environmental protection field: PPS fiber filter media, used in smelting, chemical, building materials, thermal power, waste incinerators, coal-fired boilers and other industries with high temperature and harsh working conditions, is a high quality and efficient high temperature resistant filter media.

Tableware field: used to make chopsticks, spoons, bowls and plates and other tableware.

### h. Polyurethane-PU (Urethane)

**Introduction:**

Urethane, also known as polyurethane PU elastomer, is a material with good strength and small compression deformation. It is a new material between plastic and rubber, with the rigidity of plastic and the elasticity of rubber. It is a widely used, alternative to rubber. Urethane is another name for polyurethane rods/plates. It is available in two forms: rods and sheets.

Urethane rubber has the characteristics of cushioning, silence, shock absorption, wear resistance, high temperature resistance, etc. It is durable and suitable for the protective treatment of the surface of equipment with strong acid and alkali working environment, while improving the wear resistance of equipment and reducing noise, etc. PU plates, rods and sheets have strong recovery elasticity and can be compressed by 50%; high strength, durable and cannot be replaced by...
can be compressed by 50%, high strength, durable and cannot be replaced by materials such as rubber. PU series elastomers have superior tensile strength, tear resistance, high elasticity, high pressure load resistance, wear resistance and other characteristics, and are easy to cut, grind, drill and other processing, can be applied to mechanical cushioning materials, punching molds, recoil pads, bending and forming. Seals and toothed joints used in industrial machinery and equipment. They are oil and wear resistant and have a hardness between 25 and 98 degrees Shore. They have good strength and solubility, can be used in harsh environments and have good ageing resistance, long service life and a wide range of specifications.

Application areas:

It is used in the fields of textile, medical, construction, building materials, automobile, national defence, light industry, chemical industry, electronics, aerospace, aviation, etc.

i. Polyvinyl chloride-PVC

Introduction:

Polyvinyl chloride (PVC) is a polymer made from vinyl chloride monomer (VCM) polymerised by peroxide, azo compounds and other initiators, or by the mechanism of free radical polymerisation under the action of light and heat. Vinyl chloride homopolymers and vinyl chloride copolymers are collectively called vinyl chloride resins.

PVC is an amorphous white powder with a small degree of branching and a glass transition temperature of 77-90°C. It starts to decompose at around 170°C. [1] It has poor stability to light and heat, and will decompose above 100°C or after prolonged exposure to sunlight to produce hydrogen chloride, and further autocatalytic decomposition, causing discolouration and a rapid decline in physical and mechanical properties.
The molecular weight of industrially produced PVC is generally in the range of 50,000 to 110,000, with a large polydispersity, the molecular weight increases as the polymerisation temperature decreases, there is no fixed melting point, 80°C to 85°C begins to soften, 130°C becomes viscoelastic, 160 to 180°C begins to change into a viscous flow state; has good mechanical properties, tensile strength of about 60MPa, impact strength 5 to 10kJ/m²; has excellent dielectric properties.

PVC was once the world's largest general-purpose plastic in terms of production and is very widely used. It is widely used in construction materials, industrial products, daily necessities, floor leather, floor tiles, artificial leather, pipes, wires and cables, packaging films, bottles, foaming materials, sealing materials, fibres, etc.

**Application areas:**

Widely used in construction materials, industrial products, daily necessities, floor leather, floor tiles, artificial leather, tubes, wires and cables, packaging films, bottles, foaming materials, sealing materials, fibres, etc.

**j. Epoxy sheet-FR-4**

**Introduction:**

FR-4 is a code name for a flame-resistant material grade, which means that the resin material must be able to extinguish itself after a burning condition.

FR-4 Epoxy Glass Cloth laminate, depending on the application, is generally known in the industry as: FR-4 Epoxy Glass Cloth, Insulation Board, Epoxy Board, Epoxy Resin Board, Brominated Epoxy Resin Board, FR-4, Glass Fibre Board, Glass Fibre Board, FR-4 Reinforcement Board, FPC Reinforcement Board, Flexible PCB Reinforcement Board, FR-4 Epoxy Resin Board, Flame Retardant Insulation Board, FR-4 4 laminate, epoxy board, FR-4 light board, FR-4 glass fibre board, epoxy glass cloth board, epoxy glass cloth laminate, circuit board drilling mat board. Main technical characteristics and applications: stable electrical insulation properties
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- **Technical characteristics and applications:** Stable electrical insulation properties, good flatness, smooth surface, no pits, standard thickness tolerance, suitable for application in products with high performance electronic insulation requirements, such as FPC reinforcement board, PCB drilling mat board, glass fibre meson, potentiometer carbon film printed glass fibre board, precision wandering star gear (wafer grinding), precision test plate, electrical (electrical) equipment insulation spacer plate, insulation mat board Insulation plates for electrical (electrical) equipment, insulating plates for transformers, insulating parts for motors, grinding gears, insulating plates for electronic switches, etc.

**Application areas:**

FR-4 epoxy glass fiber board (epoxy board), the main material is imported semi-curing sheet, the colour is white, yellow, green, at room temperature 150 °C still have high mechanical strength, dry state, wet state electrical properties, flame retardant, used in electrical, electronic and other industries insulation structure parts, the use of imported raw materials, domestic press and standard technology carefully manufactured

**k. Polyethylene-HDPE**

**Introduction:**

High density polyethylene (HDPE), a white powder or granular product. Non-toxic, tasteless, crystallinity of 80% to 90%, softening point of 125 to 135°C, use temperature up to 100°C; hardness, tensile strength and creep better than low-density polyethylene; wear resistance, electrical insulation, toughness and cold resistance is good; chemical stability is good, at room temperature, insoluble in any organic solvent, resistant to acid, alkali and various salt corrosion; film permeability to water vapor and air Low water absorption; poor ageing resistance, less resistant to environmental stress cracking than low density polyethylene, especially thermal oxidation can reduce its performance, so the resin must be added to antioxidants and UV absorbers to improve this aspect of deficiencies.
High-density polyethylene film has a lower heat deflection temperature under stress and should be applied with care.

Application areas:

High density polyethylene resins can be moulded into plastic products by injection, extrusion, blow moulding and rotational moulding. Injection moulding can be used to produce various types of containers, industrial parts, medical products, toys, shells, corks and shrouds. Blow moulding can be used to form a variety of hollow containers, ultra-thin films, etc. Extrusion moulding can be used to form tubes, stretch strips, strapping, monofilaments, wire and cable sheaths, etc.

In addition, we can also mould decorative panels for buildings, shutters, synthetic wood, synthetic paper, synthetic film and calcium-plastic products.

Feature:

High density polyethylene has good heat and cold resistance, good chemical stability, high rigidity and toughness, and good mechanical strength. Dielectric properties and resistance to environmental stress cracking are also good. Hardness, tensile strength and creep are better than low density polyethylene; abrasion resistance, electrical insulation, toughness and cold resistance are better, but slightly worse than low density insulation; chemical stability is good, at room temperature, insoluble in any organic solvent, resistant to acid, alkali and various salts corrosion; film permeability to water vapour and air is small, low water absorption; poor ageing resistance, environmental cracking resistance is not as good as low density Polyethylene, especially thermal oxidation, can reduce its performance, so the resin needs to be improved by adding antioxidants and ultraviolet absorbers to improve this aspect. The heat deflection temperature of high density polyethylene film is lower under stress, which should be noted when applying.
1. Polyethylene-LDPE

**Introduction:**

High pressure low density polyethylene (high pressure-low density polyethylene, HP-LDPE, abbreviated as LDPE) has been industrialised for more than 70 years, although with the discovery and development of olefin polymerisation catalysts, there has been great progress in the variety and production of polyethylene, but high pressure polyethylene still occupies an important position. Ethylene is polymerised into high molecular weight polyethylene by a free radical mechanism at high temperature and pressure, with the following characteristics.

- (1) The reaction process of ethylene polymerisation is a strongly exothermic process. The heat of polymerization of ethylene is about 93.5kJ/mol (or 3.3kJ/g), and the specific heat capacity of ethylene is 2.51-2.85J/(g·°C) at 235MPa and 150-300°C. If the reaction heat cannot be removed in time, every 1% of ethylene polymerization will increase the temperature by 12-13°C. If the temperature is too high, it will also lead to the decomposition of ethylene.

- (2) under high pressure, ethylene has been compressed to a density of 0.5g/mL gas-tight phase state, close to the liquid can no longer be compressed, at this time the distance between the ethylene molecules significantly shortened, thus increasing the probability of collision between the free base and ethylene molecules, so easy to polymerization reaction.

- (3) The free radical activity of the growing chains is high at high temperatures, and chain transfer reactions can easily occur, resulting in a linear polymer with more branched chains. Usually there are 20-30 branched chains per 1000 carbon chain atoms, with a crystallinity of 45%-65% and a density of 0.910-0.925g/mL, which is light, flexible and has good low temperature and impact resistance.

**Application areas:**

**Application range of LDPE: Suitable for food packaging such as seasoning, pastry.**

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Application range of LDPE: Suitable for food packaging such as seasoning, pastry, sugar, preserves, biscuits, milk powder, tea, fish and meat pine. Packaging for pharmaceuticals such as tablets and powders, shirts, garments, knitted cotton products and chemical fibre products, etc. Packaging for daily chemical products such as laundry detergent, detergent and cosmetics. Due to the poor mechanical properties of single-layer PE film, it is usually used as the inner layer of composite packaging bags, i.e. multi-layer composite film heat sealing substrate.

Product properties.

The characteristics of LDPE are mainly as follows.

- (1) The film is slightly opalescent and transparent and soft. The strength is less than HDPE and the impact strength is greater than HDPE.

- (2) Cold and low temperature resistance and resistance to higher temperatures. Thicker films can withstand the sterilisation process by immersion in hot water at 90°C.

- (3) Moisture resistance is better, chemically stable and insoluble in general solvents.

- (4) There is a large air permeability, so when used as oxidation-prone food packaging, the storage period of its contents should not be too long.

- (5) Poor grease resistance, products can be slowly dissolved up. Packaging containing grease food, long storage will make the food appear harsh taste.

- (6) A long period of ultraviolet light and heat will be aging, affecting its physical properties and dielectric properties.

- (7) Melting point is 110~115°C, processing temperature is 150~210°C, if inert gas, the temperature can reach 300°C still stable. However, the melt is susceptible to degradation when in contact with oxygen.
Introduction:

Its nomenclature is determined by the specific number of carbon atoms of the synthetic monomer, e.g. nylon-6, 66, 1010, 610, etc.

It has high crystallinity and a significant melting point; high surface hardness, wear resistance, low coefficient of friction, self-lubrication and sound deadening. Good low temperature performance, with some heat resistance (can be used below 100 degrees). Non-toxic, odourless, non-mouldy, self-extinguishing, good weather resistance, but poor dyeability.

It was invented by the famous chemist Carothers and his scientific team at DuPont, the largest chemical industry company in the USA.

The nylon range is the most important engineering plastic. It is the most widely used of the five engineering plastics, covering almost every field.

Application areas:

With a wide range of applications covering almost every field, it is the most widely used of the five engineering plastics.

Types:

The main types of extruded nylon sheet commonly used in the market today are as follows.

- 1: Nylon 6 (white): This material has the most superior combination of properties, including mechanical strength, stiffness, toughness, mechanical shock absorption and wear resistance. These properties, combined with good electrical insulation and chemical resistance, make Nylon 6 a “general purpose” material used in the manufacture of mechanical and serviceable parts.

- 2: Nylon 66 (cream): Compared to Nylon 6, its mechanical strength, stiffness, heat and wear resistance, and creep resistance are better, but impact strength and mechanical damping properties are reduced, making it ideal for automatic
and mechanical damping properties are reduced, making it ideal for automatic lathe machining.

- 3: Nylon 4.6 (red-brown): Compared with ordinary nylon, nylon 4.6 is characterised by strong rigidity, good creep resistance and more heat resistance to ageing in a wider temperature range. High temperature areas (80 – 150 °C)

- 4: Nylon 66 + GF30 (black): compared to pure nylon 66, this nylon is filled with 30% glass fibre reinforcement for its heat resistance, strength, stiffness. Creep resistance and dimensional stability, wear resistance and other performance aspects have been improved, its maximum allowable use temperature is higher.

- 5: Nylon 66 + MOS2 (grey-black): this nylon is filled with molybdenum disulphide, compared with nylon 66, its rigidity, hardness and dimensional stability have been improved, but the impact strength has been reduced, the grain formation effect of molybdenum disulphide has improved the crystalline structure, so that the material load-bearing and wear resistance have been improved.

**Main characteristics:**

Good ageing resistance, good mechanical damping ability, good sliding properties, excellent wear resistance, good mechanical processing properties, no creep when used for precise and effective control, good anti-wear properties, good dimensional stability.

Anti-corrosion equipment for the production of gears and parts bad material. Wear-resistant parts, transmission structure parts, household appliance parts, automobile manufacturing parts, filaments to prevent mechanical parts, chemical machinery parts, chemical equipment, etc.

**n.Nylon-PA66**

**Introduction:**

PA66 (polyamide 66 or nylon 66), compared to PA6, is more widely used in the
PA66 (polyamide 66 or nylon 66), compared to PA6, is more widely used in the automotive industry, instrument housings and other products where impact resistance and high strength are required.

It is widely used in the manufacture of parts for mechanical, automotive, chemical and electrical devices such as gears, rollers, pulleys, rollers, impellers in pump bodies, fan blades, high pressure seals, valve seats, gaskets, bushings, various handles, support frames, inner layers of electrical wire packages, etc.

**Application areas:**

high-temperature electrical socket parts, electrical parts, gears, bearings, rollers, spring supports, pulleys, bolts, impellers, fan blades, propellers, high-pressure sealing gaskets, valve seats, oil pipes, oil storage containers, ropes, ties, drive belts, grinding wheel adhesives, battery boxes, insulated electrical parts, wire cores, draw wires, etc.

**Performance:**

PA66 plastic material is translucent or opaque milky white crystalline polymer, with plasticity. Density 1.15g/cm3. Melting point 252℃. Embrittlement temperature -30℃. Thermal decomposition temperature is greater than 350℃. Continuous heat resistance 80-120℃, equilibrium water absorption rate 2.5%. Resistant to acids, alkalis, most inorganic salt solutions, halogenated alkanes, hydrocarbons, esters, ketones and other corrosion, but soluble in phenol, formic acid and other polar solvents. It has excellent wear resistance, self-lubricating properties and high mechanical strength. However, the water absorption is large, and thus the dimensional stability is poor.

PA66 is the highest mechanical strength in the PA series, the most widely used varieties, because of its high crystallinity, so its rigidity, heat resistance are higher.
**Injection moulding process:**

PA66 plastic raw material barrel temperature.

Feed zone 60~90°C (80°C)

Zone 1 260 to 290°C (280°C)

Zone 2 260~290°C (280°C)

Zone 3 280~290°C (290°C)

Zone 4 280 to 290°C (290°C)

Zone 5 280 to 290°C (290°C)

Nozzles 280 to 290°C (290°C) Temperatures in brackets are recommended as basic settings with stroke utilisation of 35% and 65% and a moulded part flow length to wall thickness ratio of 50:1 to 100:1

The temperature of the feed zone and zone 1 is directly influencing the feeding efficiency, increasing these temperatures will result in a more even feeding

PA66 plastic raw material melt temperature: 270 ~ 290 °C barrel constant temperature: 240 °C mould temperature 60 ~ 100 °C

Injection pressure: 100 ~ 160MPa (1000 ~ 1600bar), if the processing of thin cross-section long runner products (such as wire ties), it is necessary to reach 180MPa (1800bar)

PA66 plastic material holding pressure: 50% of the injection pressure; as the material condenses relatively quickly, a short holding time is sufficient. Reducing the holding pressure can reduce the internal stress of the product

Back pressure: 2 to 8MPa (20 to 80bar), need to be accurately adjusted because
Back pressure: 2 to 8MPa (20 to 80bar), need to be accurately adjusted, because the back pressure is too high will cause uneven plasticization injection speed is recommended to use a relatively fast injection speed; mold has good ventilation or products on the easy to appear scorching phenomenon

Screw speed High screw speed with a linear speed of 1m/s; however, it is better to set the screw speed lower, as long as the plasticisation process can be completed before the end of the cooling time; the required screw torque is low

Dosing stroke (0.5 to 3.5)D

Residual material volume 2 to 6 mm depending on dosing stroke and screw diameter

Pre-drying Drying at 80°C for 4h, except when feeding directly from the charging container; nylon is absorbent and should be kept in a moisture-proof container and in a closed hopper; water content above 0.25% will cause moulding changes

Recovery rate 10% return material can be added

PA66 plastic raw material shrinkage: 0.7% to 2.0%, or 0.4% to 0.7% with the addition of 30% glass fibre; if supplied at temperatures above 60°C, the product should be gradually cooled; gradual cooling reduces post-moulding shrinkage, i.e. the product exhibits better dimensional stability and small internal stresses; the steam method is recommended; nylon products can be checked for stresses by molten solder

Gating systems Point, submerged, sheet and straight gates are all possible; blind holes and gate nests are recommended to break the cooled tip; hot runners are possible; due to the narrow temperature range of the melt to be processed, hot runners should provide closed loop temperature control

No need for cleaning with other materials during machine downtime; melt remains in the barrel for up to 20 min, after which thermal degradation is likely to occur
0. Polycarbonate-PC

Introduction:

Polycarbonate (PC for short), also known as PC plastic; is a polymer containing carbonate groups in the molecular chain, which can be divided into aliphatic, aromatic, aliphatic-aromatic and other types according to the structure of the ester group. Among them, aliphatic and aliphatic-aromatic polycarbonates have low mechanical properties, thus limiting their application in engineering plastics.

Only aromatic polycarbonates have been industrially produced. Due to its structural peculiarities, polycarbonate has become the fastest growing general engineering plastic among the five major engineering plastics.

Application areas:

- **Optical illumination**
  Used in the manufacture of large lampshades, protective glass, left and right eyepiece barrels for optical instruments, etc. Also widely used as a transparent material in aircraft.

- **Electronic appliances**
  Polycarbonate is an excellent E (120°C) insulating material, used for manufacturing insulating connectors, coil frames, tube holders, insulating sleeves, telephone housings and parts, battery cases for mining lamps, etc.. It can also be used to make parts with high dimensional accuracy, such as compact discs, telephones, electronic computers, video recorders, telephone exchanges, signal relays and other communication equipment. Polycarbonate films are also widely used as capacitors, insulating skins, audio tapes, colour video tapes, etc.

- **Machinery and equipment**
  It is used to manufacture various gears, racks, worm gears, worm gears, bearings, cams, bolts, levers, crankshafts, ratchets, as well as parts of
Bearings, cams, bolts, levers, crankshafts, ratchets, as well as parts of mechanical equipment such as housings, covers and frames.

- **Medical equipment**
  Cups, tubes, bottles, dental instruments, drug containers and surgical instruments for medical use, even artificial kidneys, artificial lungs and other artificial organs.

- **Other applications**
  In the textile industry, it is used as textile yarn tubes, textile machine tiles, etc. In daily use, it is used as milk bottles, tableware, toys, models, LED lamp housings and mobile phone housings, etc.

### Polyetheretherketone (PEEK)

**Introduction:**

Polyetheretherketone (PEEK) is a polymer containing a ketone bond and two ether bonds in the main chain structure of the repeating unit, is a special polymer materials. It has high temperature resistance, chemical resistance and other physical and chemical properties, is a class of semi-crystalline polymer materials, can be used as high temperature resistant structural materials and electrical insulation materials, and can be compounded with glass or carbon fibres to prepare reinforcing materials. It is generally used as a class of polyaryl ether polymers obtained by condensation with aromatic diphenols. This material has a large number of applications in the aerospace sector, in medical devices (as artificial bone repair for bone defects) and in industry.

**Application areas:**

Due to its excellent overall performance, polyetheretherketone PEEK can replace traditional materials such as metals and ceramics in many special areas. The plastic's high temperature resistance, self-lubrication, wear resistance and fatigue resistance make it one of today's most popular high-performance engineering plastics, which are mainly used in aerospace, automotive industry, electrical and
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- Plastics, which are mainly used in aerospace, automotive industry, electrical and electronic and medical devices.

1. Aerospace field: it can be processed into various high-precision aircraft parts, due to its hydrolysis resistance, corrosion resistance and good flame retardant properties, it can be processed into many parts of aircraft internal/external parts and rocket engines.

2. Automotive manufacturing: polyetheretherketone (PEEK) has been successfully used in the automotive manufacturing industry, as it has good friction resistance, can replace metal (including stainless steel, titanium) manufacturing engine covers, automotive bearings, seals and brake pads, etc.

3. Industrial sector: due to its good mechanical properties, high temperature resistance, wear resistance, and high pressure resistance, commonly used to manufacture compressor valve pieces, piston rings, seals, etc.

4. Medical equipment: can withstand 3000 cycles of autoclaving at 134 °C, this feature can meet the high sterilization requirements, the need for repeated use of surgical and dental equipment manufacturing, coupled with its resistance to creep and hydrolysis, it can be used to manufacture a variety of medical devices that require high-temperature steam sterilization. Particularly important is that PEEK is non-toxic, lightweight and corrosion-resistant, and is the closest material to human bone, so PEEK can be used instead of metal to manufacture human bone.

5. Insulation materials: PEEK because of its excellent electrical properties, at high temperatures, high humidity and other harsh conditions, polyether ether ketone insulation properties can still be maintained, is the ideal electrical insulation materials, especially in the semiconductor industry is widely used.

6. Is a new type of engineering plastics, can be used as high temperature resistant structural materials and electrical insulation materials, can be compounded with glass fiber or carbon fiber to prepare reinforcing materials.

7. Modified polyetheretherketone have black carbon fiber reinforced conductive polyetheretherketone, red carbon fiber reinforced conductive polyetheretherketone, have mineral reinforced polyetheretherketone, have glass fiber reinforced polyetheretherketone and PEEK resin. Although
Glass fiber reinforced polyetheretherketone and PEEK resin. Although polyetheretherketone has many excellent properties, it is expensive, limiting its use in some areas. In addition, its poor impact strength, in order to further improve its performance to meet the comprehensive performance and diversification needs of various fields, it can be filled, blended, cross-linked, grafted and other methods to modify it to get more excellent performance of PEEK plastic alloy or PEEK composite materials. For example:

PEEK and polyether blend can get better mechanical properties and flame retardancy;
PEEK and PTFE blend made of composite materials, with outstanding wear resistance, can be used to manufacture sliding bearings, dynamic sealing rings and other components;
PEEK with carbon fiber and other filler modification, made of enhanced PEEK composite materials, can greatly improve the hardness of the material, rigidity and dimensional stability, etc.

Properties.

PEEK (polyether ether ketone) plastic material is an aromatic crystalline thermoplastic polymer material with high mechanical strength, high temperature resistance, impact resistance, flame retardant, acid and alkali resistance, hydrolysis resistance, wear resistance, fatigue resistance, irradiation resistance and good electrical properties.

- High temperature resistance: It has a high glass transition temperature (Tg=143°C) and melting point (Tm=343°C), its load heat deflection temperature is up to 316°C and the instantaneous use temperature is up to 300°C.
- Mechanical properties: rigid and flexible, particularly outstanding fatigue resistance under alternating stress, comparable to alloy materials.
- Self-lubricating: excellent sliding characteristics, suitable for strict requirements of low coefficient of friction and wear-resistant applications, especially with carbon fibres, graphite each in a certain proportion of the mixture of modified PEEK self-lubricating properties better.
- Corrosion resistance: in addition to concentrated sulfuric acid, PEEK is
Corrosion resistance: in addition to concentrated sulfuric acid, PEEK is insoluble in any solvent and strong acids, strong alkalis, and resistant to hydrolysis, with high chemical stability.

- Flame retardant: self-extinguishing, even without any flame retardant, can reach UL standard 94V-0 grade.

- Easy processing: With good high temperature fluidity and high thermal decomposition temperature, it can be processed in various ways: injection moulding, extrusion, moulding and melt spinning etc.

- Peel resistance: excellent peel resistance, so it can be made into very thinly covered wires or electromagnetic wires and can be used under harsh conditions.


- Irradiation resistance: Highly resistant to high levels of irradiation, surpassing polystyrene, which has the best irradiation resistance of any general purpose resin. It can be made to maintain good insulation performance at gamma irradiation doses of up to 1100Mrad.

- Hydrolysis resistance: PEEK and its composites are chemically unaffected by water and high-pressure water vapour, and products made from this material can maintain excellent properties even when used continuously in high-temperature and high-pressure water.

- Smoke generation: PEEK has the lowest smoke generation of any plastic.

- Toxic fumes: PEEK, like many organic materials, produces mainly carbon dioxide and carbon monoxide when decomposed at high temperatures. The Toxicity Index is defined as the ratio of the combined concentration of toxic gases produced under normal conditions to the dose that would be fatal in 30 minutes, PEEK450G has an index of 0.22 and no acidic gases were detected.

- Insulation Stability: PEEK450G has good electrical insulation properties and maintains them to a very high temperature range. Its dielectric losses are also small at high frequencies.

- Stability: has superior dimensional stability characteristics, which are important for some applications. Changes in temperature, humidity and other environmental conditions have little effect on the dimensions of PEEK parts.
Environmental conditions have little effect on the dimensions of PEEK parts, and can meet the requirements of high dimensional accuracy in the workplace.

(1) PEEK plastic raw material injection molding shrinkage is small, which is very good for controlling the range of dimensional tolerances of PEEK injection molded parts, so that the dimensional accuracy of PEEK parts is much higher than that of general-purpose plastics.

(2) Small coefficient of thermal expansion, with the change in temperature (can be caused by changes in ambient temperature or frictional heat generation during operation), the size of PEEK parts change very little.

(3) Good dimensional stability, the dimensional stability of plastics refers to engineering plastics products in use or storage in the process of dimensional stability of performance, this change in size is mainly due to the activation energy of polymer molecules increased, so that the chain segments have some degree of curl caused by; (4) PEEK heat resistant hydrolysis, the PEEK parts are not the same.

(4) PEEK heat-resistant hydrolysis properties outstanding, in high temperature and high humidity environment, water absorption is very low, will not appear similar to nylon and other general-purpose plastics due to water absorption and size change significantly.

7. Special materials and others

a. Carbon fibre panels

Introduction:

Carbon fibre sheets are carbon fibres arranged in the same direction using resin infiltration and hardening to form carbon fibre sheets, which can effectively solve the problem of difficult construction of multi-layer carbon fibre cloth and large volume of works, with good reinforcement effect and convenient construction.
Using high quality carbon fibre raw materials and good basic resin, carbon fibre sheets have high tensile strength, corrosion resistance, shock resistance, impact resistance and other good properties.

**Introduction:**

Concrete beam bending and shear reinforcement, concrete floor and bridge slab reinforcement, concrete and brick masonry walls, scissor wall reinforcement, bridge piers, piles and other columns reinforcement, chimneys, tunnels, pools, concrete pipes and other reinforcement. It is also commonly used for the production of multi-rotor drone bodies, such as traversing aircraft, aerial drones, etc.

**Technical features:**

1. High strength and high efficiency
   Tensile strength is more than several times that of ordinary steel, modulus of elasticity is better than that of steel, excellent creep resistance, corrosion resistance and shock resistance.

2. Light weight, good flexibility
   The carbon fibre sheet has high strength and is only 1/5 of the quality of steel, with high toughness, can be coiled and supplied in larger lengths without laps.

3. Convenient construction, easy to guarantee construction quality
   The material does not need to be pre-processed, the process is convenient and the panels are allowed to cross.

4. Good durability and corrosion resistance
   Resistant to acid, alkali, salt and atmospheric corrosion, no regular maintenance required.
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