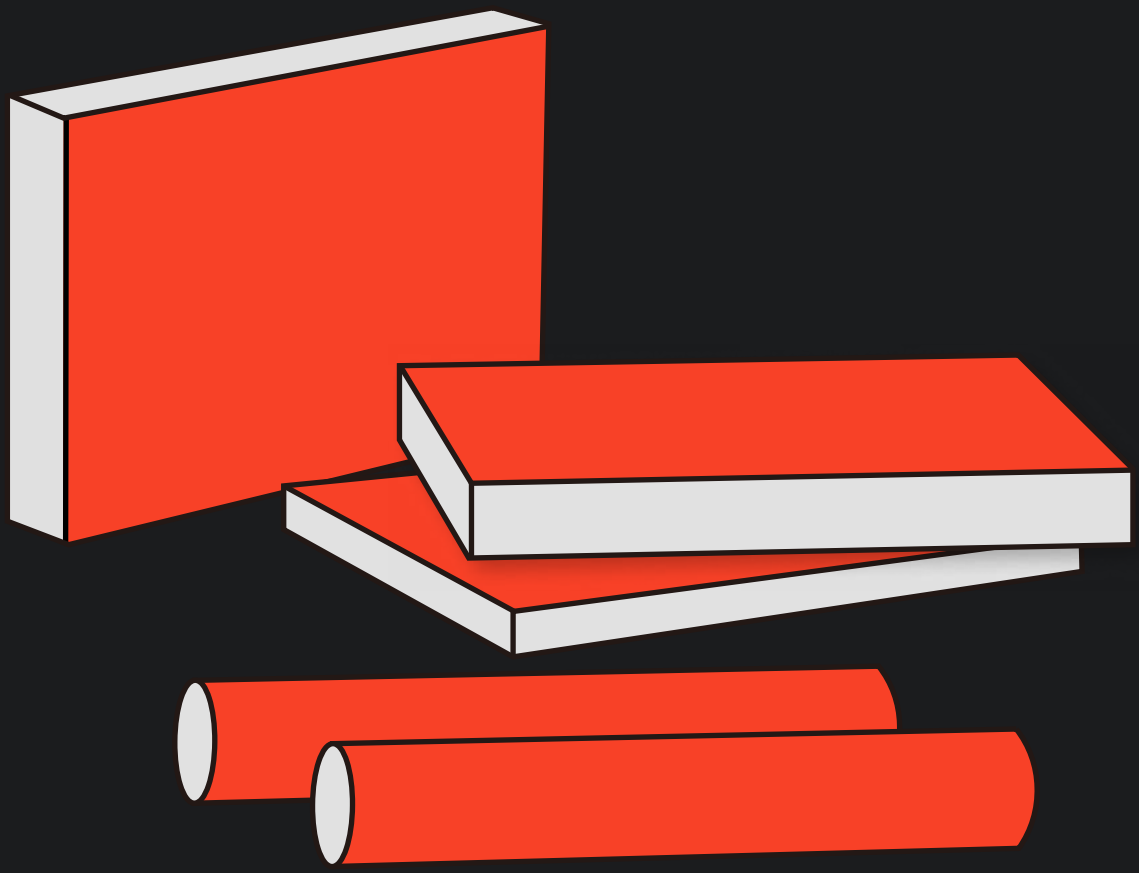
RAPID® DIRECT



Metal Materials Whitepaper

Metal Materials for Manufacturing

-November / 2022

Table of Contents

Aluminium

Introduction

01

Aluminum is the most abundant metal element in the earth's crust. Aluminum was introduced and named in the early 18th century. At the end of the 19th century, aluminum was first used in commerce, when it was a new material that attracted the attention of many people. At that time, the metal was mostly used to make tableware or kitchen utensils.

By 1950, the use of aluminum metal (alloy) reached another new era, because of its excellent light and strong properties, it began to be used in architectural design and automobile manufacturing.

Although aluminum has a relatively short history of use, the production of aluminum products on the market now far exceeds that of all other non-ferrous metals combined.

Characteristics

- Small specific gravity
- Flexible and moldable, easy to alloy
- Easy to conduct heat and electricity
- Excellent corrosion resistance
- Easy to process
- High specific strength
- Recyclable

Organoleptic Properties

Visual: Opaque, glossy
Tactile: Hard, cool
Aural: High pitch
Sense of smell: No odor

Form

Silk, wire, foil, powder, braid, foam, sheet, rod, profile

Applicable Techniques

Rolling, extruding, drawing, forging, machining, anodizing

Applications

Transportation - Car, ship parts, etc.
Aerospace - Shell skin, structure, parts, etc.
Construction - Building decoration materials, building load-bearing structures, etc.
Chemical - Chemical reactors, refrigeration units, oil and gas pipelines, etc.
Container packaging - Beverage cans, aluminum boxes, etc.
Creative design - Art installation, cultural and creative products, etc.

Aluminum Foam

Aluminum foam is a kind of foam aluminum alloy material developed by the experts of Russian Institute of Lightweight Alloys, which has the advantages of low density, strong impact absorption, high temperature resistance, strong fireproof performance, corrosion resistance, sound insulation and noise reduction. Due to the different alloy composition contained in aluminum, the different heating procedures and the different vaporized powders obtained during the synthesis of the new material, the final obtained foam aluminum alloy has different densities and the pores of the foam are large or small.

Aluminum foam is acoustically and thermally insulating, non-toxic and non-flammable, can be sawn and milled, and screws can be driven into it. This new material, which is light, strong and not afraid of fire, can be used for the veneer of elevator doors and the flooring of train and subway cars.

Extruded aluminum bubbles, used in architecture, are also a very unique design element. The bubbles appear to be frozen on these semi-"melted" metal surfaces, and the panels have different thicknesses and sound absorption effects. The pore size of the aluminum foam can be adjusted through process control during the molding process to achieve different surface effects.

Stainless Steel

Introduction

02

Stainless steel is an alloy made by incorporating chromium, nickel and some other metal elements into steel. From the name As you can see, its greatest characteristic is its perfect "rust and corrosion resistance".

Stainless steel's non-rusting properties come from the chromium content of the alloy, which forms a strong, self-healing layer on the surface of the alloy. Chromium forms a firm, self-healing film of chromium oxide on the surface of the alloy, which is invisible to the naked eye. We usually refer to the ratio of stainless steel to nickel is generally 18:10.

The "father of stainless steel" a Henry Brierley in 1916 obtained the British patent for stainless steel and began mass production, from then on, stainless steel from the trash heap accidentally found the world will be popular, designers Designers developed many new products around its toughness and corrosion resistance, involving a lot of previously never involved in many areas that had never been involved before.

Characteristics

- Perfect corrosion resistance
- Fine surface treatment available
- High temperature resistance
- High rigidity
- More difficult to cold process
- Recyclable

Organoleptic Properties

Visual: Opaque, reflective
Tactile: Hard, cold
Aural: High pitch
Sense of smell: No odor

Form

Filaments, powders, braids, plates, rods, profiles

Applicable Techniques

Bending, forging, drawing, rolling, most of the metal surface treatment processes

Applications

Stainless steel is divided into four main types: austenitic, ferritic, ferritic an austenitic (composite) martensite.
Austenitic stainless steel - Mainly used in household products, industrial piping and building structures
Martensitic stainless steel - Mainly used for making knives and turbine blades
Ferritic stainless steel -Corrosion resistant and is mainly used in durable washing machines and boiler parts.
Composite stainless steel - Stronger anti-corrosion properties, so it is often used in aggressive environments

Kitchen Appliances

Stainless steel is actually a spin-off from the development of weapons materials. This non-abrasive steel, can not make weapons, but because of his resistance to rust and corrosion, was used to make cutlery and knives. Later, it was gradually used in large quantities in the kitchen, which has the risk of corrosion and high heat environment.

Deodorizing Soap

Another interesting point is that stainless steel can also remove the skin odor, so making it in the shape of a pebble can also be used as a fat soap to cleanse the skin.

Medical Devices

Many design attempts of stainless steel are very revolutionary for example, sterilized and reusable medical devices medical equipment first appeared in the medical industry.

Copper

Introduction

03

Copper was one of the first metals used by man. As early as prehistoric times, people began to mine copper in the open air The use of copper had a profound impact on the progress of early human civilization, as the copper obtained was used to make weapons, tools and other vessels and blood. The use of copper had a profound impact on the progress of early human civilization.

Pure copper is red-orange with a metallic luster when the surface is first cut, and purplish-red in its pure form. It can be mixed with other metals to form copper alloys with different characteristics, such as bronze when mixed with tin and brass when mixed with zinc.

It is an excellent material for making musical instruments because of the unique sound it produces. In addition, it can be mixed with aluminum, nickel, beryllium, etc. to form copper alloys with different properties, and there are about 400 kinds of copper alloys so far.

Characteristics

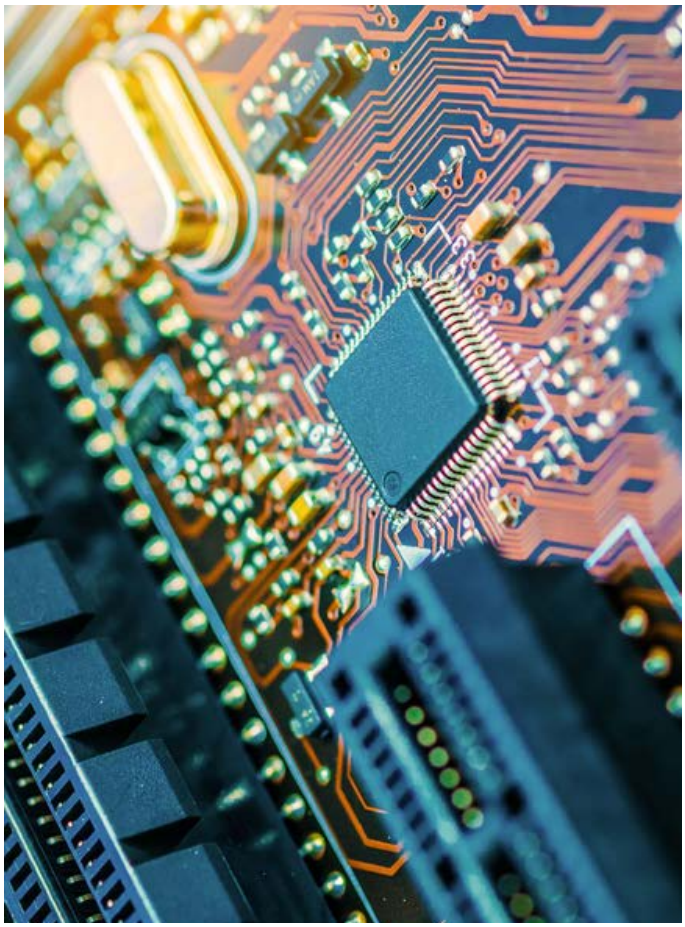
- Good ductility and softness
- Good electrical and thermal conductivity, second only to silver among metal monomers at room temperature
- Easy to form various alloys with other metals with different characteristics
- Can be recycled many times without loss of its mechanical properties
- Very strong bactericidal effect

Organoleptic Properties

Visual: Reflective, opaque, glossy
Tactile: Hard and cold
Aural: High pitch
Sense of smell: No odor

Form

Silk, thread, braid, foam, sheet, bar



Applicable Techniques

Handcraft, casting, rolling, stretching, extrusion

Applications

Craft collection - Coins, musical instruments, jewelry decorations, handicrafts, etc.
Electronic appliances - Cable and electrical, electronic components, etc.
Military industry - Bullets, artillery shells, gun parts, etc.
Chemical field - Vcuum, distillation pot, brewing pot, etc.
Construction - Decorative materials, pipe fittings, etc.

Brass

Brass is an alloy of copper and zinc, so named because of its yellow color. Brass mechanical properties and wear resistance are very good, can be used in the manufacture of precision instruments, ship's parts, gun shells, etc. Brass sounds good when knocked, so gongs, cymbals, bells, horns and other musical instruments are made of brass.

In order to improve the brass corrosion resistance, strength, hardness and machinability, etc., in the copper a zinc alloy with a small amount of tin, aluminum, manganese, iron, silicon, nickel, lead and other elements, constitute a ternary, quadruple, or even five element alloy, that is, complex brass, also known as special brass.

Bronze

Bronze is the earliest alloy in the history of metal smelting and casting. The alloy of tin or lead added to pure copper (purplish copper) has special importance and historical significance, and bronze has good castability, wear resistance and chemical stability.

Bronze has a low melting point, high hardness, high plasticity, wear resistance, corrosion resistance, and bright color.

Bronze also has a perverse characteristic - "heat shrinkage and cold expansion", which is used to cast statues and expand after cooling to make the eyebrows clearer.

In ancient times, it was used in five categories: food, wine, water, musical instruments, and weapons. In modern times, bronze is used in industrial products, such as precision bearings, high-pressure bearings, seawater corrosion-resistant mechanical parts for ships, and various plates, tubes, and rods.

White Copper

White copper is a copper-based alloy with nickel as the main additive element. It is silvery white, has a metallic luster and is not easily rusted. The nickel content of white copper is generally 25%.

The addition of nickel to pure copper significantly improves strength, corrosion resistance, hardness, resistance and thermoelectricity, and reduces the resistivity temperature coefficient. Therefore, the mechanical and physical properties of white copper are exceptionally good compared to other copper alloys, with good ductility, high hardness, beautiful color, corrosion resistance, and rich deep-drawing properties. It is widely used in shipbuilding, petrochemical, electrical, instrumentation, medical equipment, daily necessities, handicrafts and other fields, and is also an important resistance and thermal The disadvantage of white copper is that it is mainly added to the element.

The disadvantage of white copper is that the main additive element - nickel, is a scarce strategic materials, the price is more expensive.

Titanium

Introduction

04

Titanium is named after the ancient giant gods of Greek mythology, the Titan, known as "the embodiment of natural power". The name shows that titanium is a material with excellent performance. Titanium is a very special metal, very light in texture, yet very tough and corrosion-resistant, at room temperature It retains its hue throughout its life.

In the 1950s and 1960s, it was mainly developed for aerospace. The main focus was on the development of high-temperature titanium alloys for aircraft engines and structural titanium alloys for airframes.

Characteristics

- Very high strength, weight ratio
- Excellent corrosion resistance, stability
- Difficult to cold process
- Refining difficulties
- Good low temperature performance
- Good biocompatibility

Organoleptic Properties

Visual: Low gloss
Tactile sensation: Cold, hard
Aural: High pitch
Sense of smell: No odor

Form

Sheet, strip, foam, powder

Applicable Techniques

Casting, injection molding, cutting, machining

Applications

Aerospace - Engine compressor parts, structural parts for rockets, missiles and high-speed aircraft, etc.
Medical - Implant Materials
Chemical - White pigments for paper, painting and plastics, etc.
Industry - Electrodes for electrolysis industry, condensers for power stations, heaters for oil refining and desalination, etc.
Personal consumer goods - Golf clubs, tennis rackets

Aerospace

Titanium alloy has the name of "space metal", is a good material for making the shell of rocket engine and artificial satellite, spacecraft. Titanium has a small density, high temperature resistance, corrosion resistance and other excellent characteristics, both high temperature resistance, and low temperature resistance, in -253 ° C ~ 500 ° C such a wide range of temperatures can maintain high strength. These advantages are the necessary space metal.

It was first used in the U.S. in 1950 in the F-84 fighter-bomber as a rear fuselage heat shield, windshield, tail section, and tail section. In the 1960s, the use of titanium alloys shifted from the rear fuselage to the tail cowl and other non-load-bearing components. The use of titanium alloys moved from the rear fuselage to the center fuselage, partially replacing structural steel in the manufacture of bulkheads, beams, and flap slides. The use of titanium alloys moved from the rear fuselage to the mid-fuselage in the 1960s, partially replacing structural steel for important load-bearing elements such as frames, beams, and flap rails.

Medical Implant Materials

Titanium is a pure metal. Because of the "purity" of titanium metal, no chemical reaction will occur when substances come in contact with it. In other words, with its corrosion resistance and high stability, titanium does not affect its nature even after long-term contact with people, and does not cause allergies in people.

It is the only metal that has no effect on human plant nerves or taste, and is known as a "pro-biotic metal" and is often used to make human prostheses or implanted in the body to replace human bones.

Pigments

Almost all white pigments are extracted from titanium ores, and 95% of titanium is processed and extracted as titanium dioxide pigment (titanium dioxide) for use as a white pigment in paintings and plastics.

Also, because of its excellent biocompatibility, a large number of white products that are closely related to our lives, including paper and toothpaste, contain titanium as a metal.

Zinc

Introduction

05

Zinc, with a silvery and slightly blue-gray color, is the third most widely used non-ferrous metal after aluminum and copper. It is also the third most widely used non-ferrous metal after aluminum and copper, and is an essential trace element that must be taken in throughout a person's life. Zinc alloy is an alloy made up of zinc metal and other elements.

Characteristics

- Low melting point, good flowability
- Shattering at room temperature
- Easy fusion welding, brazing and plastic processing
- Good mechanical properties and wear resistance at room temperature
- Corrosion resistant in the atmosphere
- Easy to recycle and remelt
- Good casting performance, can die-cast complex shape, thin-walled precision parts, smooth casting surface
- Low cost

Organoleptic Properties

Visual: Opaque, reflective
Tactile sensation: Hard, cold
Aural: High pitch
Sense of smell: No odor

Form

Block, plate

Applicable Techniques

Die casting, welding, surface treatment

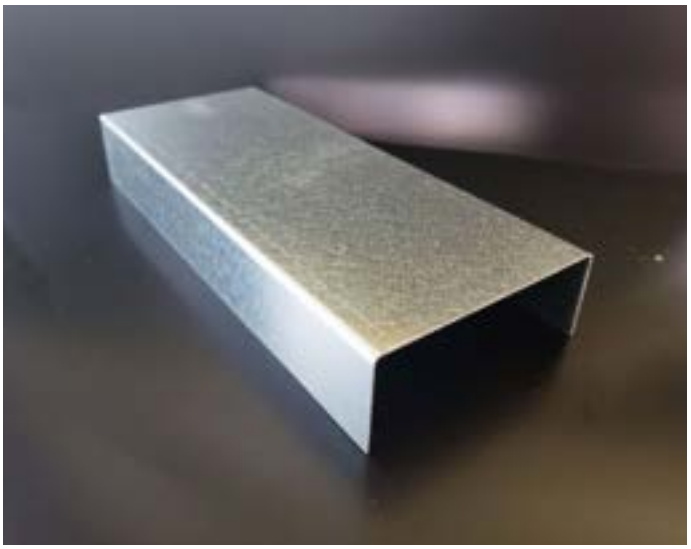
Applications

Products made purely of zinc are hardly found in the market, but are usually alloys or coated, and zinc castings are very common in our daily life.
Galvanized coating - Automotive, construction, shipping, light industry, etc.
Electronic appliances - Electronic components, cell phone antennas, shutter devices in cameras, etc.
Automobile - Die-casting instrument, automobile parts shell, etc.
Daily use - Jewelry, door handles, kitchen and bathroom appliances, etc.

Galvanizing

The largest use of zinc is in the galvanizing industry, where a layer of zinc is plated on the surface of steel alloy materials for aesthetic and rust prevention purposes. The main methods used are hot-dip galvanizing and electro-galvanizing, which are widely used in the automotive, construction, marine, and light industrial industries.

The galvanizing process is versatile and can be used to produce everything from small rivets and screws to tens of meters of structural building parts without the need for molds, short production cycles and low costs.



Casting

Zinc is a highly desirable casting material. Zinc has a very low melting point, and it is this property that makes casting so good, so that one can easily and quickly make fine and complex parts or accessories from zinc. Zinc alloys are the most likely alternative to plastic among metals.

Magnesium

Introduction

06

Magnesium is the lightest of the practical metals in the periodic table, with a specific gravity of about 2/3 that of aluminum and 1/4 that of iron.

Magnesium refining and manufacturing has nearly 100 years of history, before due to easy corrosion and expensive and can not be used in large quantities, only a small number of applications in aviation, aerospace and military industry, and therefore is known as "noble metal".

In recent years, with the development of corrosion-resistant magnesium alloys and the mass production of magnesium alloys in China and other places, people gradually changed the previous stereotypes. Magnesium and magnesium alloy is now the third largest metal engineering material after steel and aluminum.

Characteristics

- Lighter than weight
- High specific strength and specific stiffness
- Good thermal and electrical conductivity
- Good damping and shock absorption
- Good electromagnetic shielding performance
- Easy to process and shape
- Easy to recycle

Organoleptic Properties

Visual: Opaque, glossy
Tactile sensation: Hard, cold
Aural: High pitch
Sense of smell: No odor

Form

Powder, plate, strip, bar

Applicable Techniques

Die casting, rolling, extrusion, forging, casting

Applications

Consumer electronics - Product shell, branch support frame, etc.
Automotive- clutch housing, valve cover, instrument panel, transmission body and other housing; steering wheel, steering bracket, brake bracket, seat frame and other brackets
Aerospace military - Hubs, engine gear magazines, oil pumps and tubes, instrument pods, tailpipes and engines mounts, etc.
Medical - Cardiovascular stents and other implantable materials
Daily use - Sporting goods, LED lights, glasses frames, etc.

Magnesium Alloy In Automotive Applications

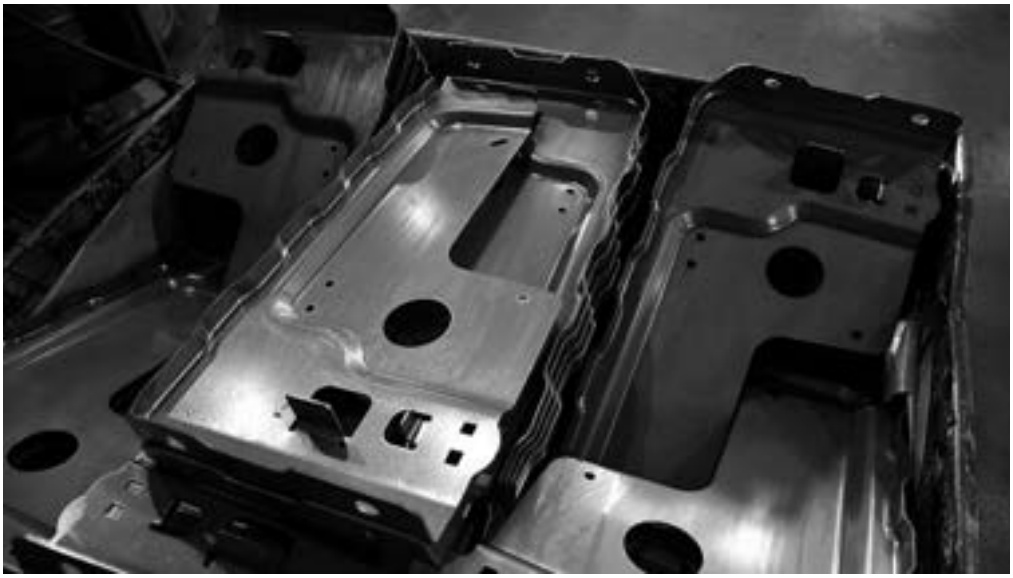
Magnesium die casting is the lightest of all die casting alloys, making it a highly competitive material for automotive lightweighting. A large number of magnesium alloy parts are produced to replace plastic, aluminum, and even steel parts. With the development of technology, magnesium alloy will be more widely used in the automotive field.

At present, the application of magnesium alloy parts in the automobile can be summarized into 2 categories.Shell class a clutch housing, valve cover, instrument panel, transmission body, crankcase, engine front cover, cylinder head, air conditioning unit shell, etc.; bracket class a steering wheel, steering bracket, brake bracket, seat frame, mirror bracket, distribution bracket, etc.

Magnesium Alloy In Consumer Electronics

In the field of consumer electronics, the market is demanding highly integrated, slim, miniaturized and compliant electronic and communication products. products to be highly integrated, thin and light, miniaturized and environmental requirements. Engineering plastics as the main housing material, its strength can not be compared with metal after all.

Magnesium alloy has excellent thin wall casting performance, its die-casting wall thickness of 0.6~1.0mm, and maintain a certain strength, stiffness and impact resistance, which is very conducive to This is very conducive to the requirements of ultra-thin, ultra-light and miniaturization of products.



Cast Iron

Introduction

07

Cast iron is a general term for cast iron-carbon alloys with carbon content ranging from 2% to 6.67%, usually made of pig iron, scrap steel It is usually made of pig iron, scrap steel, iron alloy, etc. in different proportions by melting.

The higher the carbon content, the better the flow characteristics during the casting process. The higher the carbon content, the better the flow characteristics. Because of its excellent fluidity and the ease of casting into various complex forms, cast iron has a large and wide range of applications. cast iron has a large and wide range of applications.

Characteristics

- Excellent mobility
- Good abrasion resistance
- Low solidification shrinkage
- Good machinability
- Brittle, poor impact resistance
- Low cost

Organoleptic Properties

Visual: Reflective, opaque, low gloss
Tactile sensation: Hard, cold
Aural: Hgh pitch
Sense of smell: No odor

Form

Plate, bar

Applicable Techniques

Casting, cutting, forging

Applications

Construction
Home and kitchen appliances
Mechanical engineering - automobiles, tractors, agricultural machinery and railway parts, etc.

Classification

White cast iron - White cast iron in the vast majority of carbon in the form of carburized body (FegC), the fracture is white bright color, the nature of brittle hard, rarely used alone.

Gray cast iron - The most widely used type of cast iron in the industry today because of its low cost, excellent castability, processability, vibration damping and intermetallic friction.

Malleable cast iron - Obtained by graphitizing and annealing white cast iron of a certain composition, with graphite in the form of flocculent clusters and higher plasticity than gray cast iron.

Ductile iron - High performance cast iron obtained by spheroidizing and breeding treatment of white cast iron, the graphite precipitated is spherical so it is called ductile iron. The plasticity and toughness of ductile iron are greatly improved compared to Xitong cast iron, so it can be used in some range of "iron instead of steel".

Permoleum cast iron - a worm-like graphite in ductile iron, the head is more round, has the advantages of higher strength than gray cast iron, better casting performance than ductile iron, and good heat resistance and fatigue performance.

Cast Iron Manhole Covers

Sewer covers, an inconspicuous part of our daily environment, are rarely noticed, and most of them are made of cast iron.

The presence of graphite in cast iron gives the sewer cover excellent wear resistance. There are special measures to prevent rusting during the pouring process, i.e. a bituminous coating is added to the surface of the casting, and the bitumen penetrates into the fine pores of the cast iron surface, thus acting as an anti-rust.

Cast Iron Pot

Cast iron pots and pans are basically recognized as the best material for pots and pans. Although cast iron pots and pans do not conduct heat quickly, they are evenly heated to seal in the original flavor of food and are sturdy and durable.

The internal coating of cast iron pans is mostly enamel, both white enamel and black enamel, which is actually glass melted at about 650°C ~ 760°C and bonded to the cast iron pan to form a coating.

Gold

Introduction

08

Gold, is one of the first metals discovered by mankind, earlier than copper, tin, lead, iron and zinc. Because it is rare, special and precious. Special and precious, since ancient times is regarded as the first hardware, has "king of metal" title.

For many centuries it has been used as money, a store of value and jewelry.

Characteristics

- High density, high melting point
- Good electrical and thermal conductivity
- Low hardness, soft, easy to process
- Very good ductility, can be beaten into gold leaf and drawn into gold wire
- Chemical properties are very stable, and most chemicals are not chemically reactive, heat, moisture, oxygen and
- Most erosion agents have only a small chemical effect on gold and are suitable for coins and jewelry; however, they can be used by chlorine,
- Fluorine, aqua regia and cyanide erosion

Applications

International Reserve - Currency
Jewelry and artwork - jewelry, gold foil for statues, buildings, handicrafts of gold paste
Industrial and scientific technology - Corrosion-resistant electronic connectors, wires in integrated circuits, switch contacts, colored glass, superconductors
Medical -Repair teeth, anti-inflammatory medicine (gold salt)

Organoleptic Properties

Visual: Reflective, opaque, high gloss
Tactile sensation: Cold, hard
Aural: High pitch
Sense of smell: No odor

Form

Silk, thread, foil, block, powder

Applicable Techniques

Hand processing, lost wax casting, stamping, plating, embossing

People's praise of gold often inadvertently reflects the special process of gold, such as: "golden branches and leaves", "golden splendor", the description is an important variety of gold craft - gold foil.

Gold foil is a thin sheet of hammered gold. The traditional process of making gold foil is based on gold bars with 99.99% gold content as the main raw material, which is specially processed through more than ten procedures such as chemical washing, hammering and foil cutting to make it golden in color, shiny and soft, light as a feather and as thin as a cicada's wing, with a thickness of less than 0.12 micron.

Gold foil has a wide range of uses, the traditional gold paste process is mainly used to decorate palaces and temples; currently gold foil has been widely developed and utilized in many fields such as food, make-up, architecture, crafts and decorative lights.

Silver

Introduction

09

Silver is a soft, white, lustrous transition metal, a precious metal known and used in ancient times. It exists in nature in its pure free state (natural silver), but mostly in its chemical form.

Characteristics

- Highest conductivity, thermal conductivity and reflectivity of all metals
- High ductility, soft texture
- Chemically stable, low activity, not easily corroded by chemicals (but still can be sulfur, selenium, sulfide
- (Nitric acid, hydrofluoric acid, hydroiodic acid, chlorine and other corrosion)

Applications

Craft collectibles - Currency, jewelry and decorative items, high-priced tableware and utensils
Electrical and electronic - Electrical contact materials, composite and welding materials, photographic materials
Chemical-Catalyst, Electroplating Industry Preparation
Medical - Bandages, wound dressings, catheters and other medical devices

Organoleptic Properties

Visual: Reflective, opaque, glossy
Tactile: Hard, cold
Aural: High pitch
Sense of smell: No odor

Form

Wire, thread, foil, sheet, block

Applicable Techniques

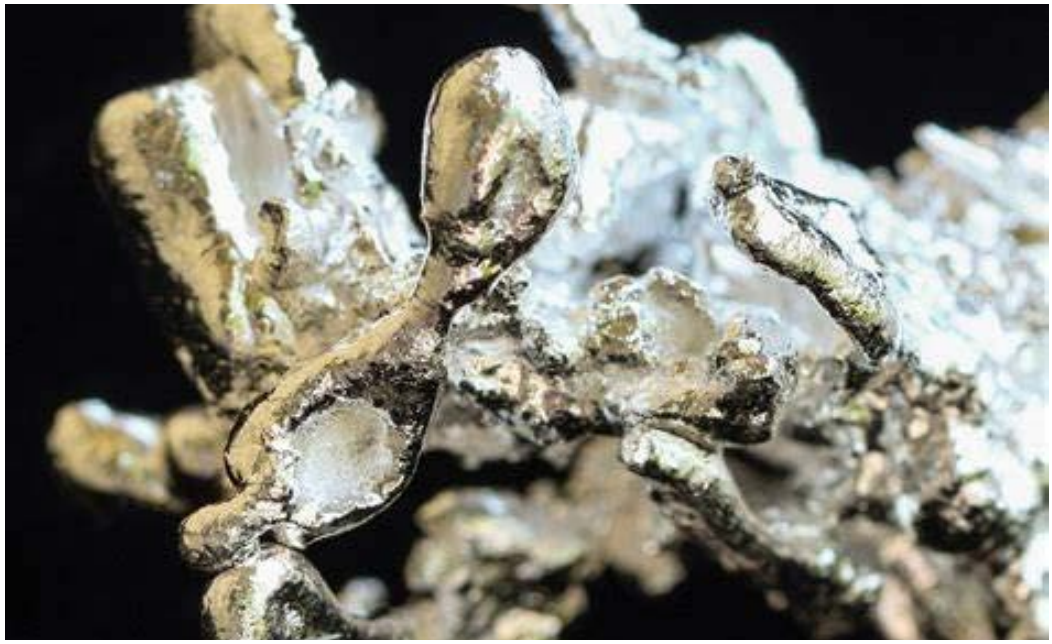
Hand processing, lost wax casting, stamping, plating, embossing

The main applications of silver are in the jewelry design industry, industrial manufacturing and the photographic industry. But the most special is the application of silver ions in sterilization.

Silver ions and compounds are toxic to certain bacteria, viruses, algae and fungi. toxicity, but it is almost completely harmless to humans, and this bactericidal effect makes it possible to This bactericidal effect allows it to kill organisms outside the living body.

Historically, the Phoenicians used to use silver bottles to hold water, wine and vinegar to prevent this liquid from rotting. In the early 20th century, silver coins were also used to keep milk fresh longer. in milk to keep it fresh longer.

Currently, silver is being used as a useful antimicrobial agent in a wide range of new applications, such as dental fillings, surgical needles, catheters, purification of drinking water (such as the use of silver-coated water storage containers in spacecraft), and, most widely, wound healing.



Tin

Introduction

10

Tin is a silvery-white soft metal, one of the oldest metals used by humans, and its main source is its oxide mineral cassiterite (SnO2), which is abundant in Yunnan, China, Malaysia, and other places.

As the industrial use of tin continues to expand, the mining, beneficiation, smelting and processing of tin has been rapidly developed, and a full range of products has gradually been formed. The tin industry has gradually formed a full range of tin industries.

Today, the ancient tin is still indispensable for modern industry. It is widely used in electronics, information, electrical appliances, chemicals, metallurgy, building materials, machinery, food packaging and other industries.

Characteristics

- Good ductility, soft and easy to bend
- Low melting point
- Little affected by water rust, but easily corroded by acids and alkalis
- Not easily oxidized in air
- Excellent corrosion resistance
- When oxygen is present in the solution, tin becomes a catalyst and accelerates chemical corrosion
- Tin becomes a superconductor when the temperature reaches below 3.72K

Organoleptic Properties

Visual: Reflective, opaque, adjustable gloss
Tactile sensation: Cold, hard
Aural: Medium pitch
Sense of smell: No odor

Form

Block, Foil

Applicable Techniques

Handicraft, casting, welding

Applications

Tinware and fine arts - Tin pots, tin cups, tin tableware, etc.
Packaging - Packaging food or medicine
Solder - Commonly used to connect pipes and electronic circuits
Tin plating - Can be plated on copper and iron, tin-plated iron sheet is called tinplate; can prevent rust and make canning containers

Tin Foil

Tin is very ductile and can be spread into very thin tin foil. Usually, people use tin foil to pack cigarettes and candy to prevent moisture. However, the ductility of tin is very poor, and it can't be pulled into a fine wire once it is pulled.

Tinplate

Because of its good stretching properties, tin is not easily oxidized in air and has excellent anti-corrosion properties, and is often used It is often used as an anti-corrosion layer for other metals.

Tinplate is a steel plate coated on both sides with tin, which gives the plate a very good corrosion resistance. Packaging accounts for 90% of tinplate's use, and it is also used for simple toys because it is relatively soft compared to other metals. It is less dangerous because it is softer than other metals.

RAPID®
DIRECT

Make On Demand Manufacturing Easier, Faster

Room 407, Building F, Tianyou Chuangke
Industrial Park, Qiaotou Community, Fuhai Street,
Baoan District, Shenzhen, China, 518103

+86-0755-85276703

info@rapiddirect.com

www.rapiddirect.com