



MATERIAL SPECIFICATIONS

CONTENTS

| | |
|---|----|
| Alloy Steel 4140..... | 2 |
| carbon Steel 1045 cr..... | 3 |
| UHB SS716 Stainless Steel | 4 |
| 316 Stainless Steel Cable | 5 |
| 304 Stainless Steel | 6 |
| 3003-H14 Aluminum | 7 |
| 5052 Aluminum (H32) | 8 |
| 6063 Aluminum (T6)..... | 9 |
| Hardened & Coated | |
| Polycarbonate (Lexan™ MR10) | 10 |
| Tritan™ Copolyester TX1501HF | 11 |
| BASF Ultramid® 8202C Polyamide 6..... | 12 |
| DuPont Tynex® A 612 Nylon..... | 13 |
| HDPE (High-density Polyethylene)..... | 14 |
| Closed Cell EPDM Sponge Rubber | 15 |
| EA E-30CL Adhesive | 16 |
| ABS (Acrylonitrile Butadiene Styrene) Plastic | 17 |

ALLOY STEEL 4140

USED IN:

Helical Blade

DESCRIPTION:

Oil-hardening chromium-molybdenum steel has good strength and wear resistance, excellent toughness and ductility with the ability to resist stress and creep at prolonged high temperatures (up to 1,000°F).

TYPICAL APPLICATIONS:

Drill collars, high temperature bolts, sprockets, kelly bars, reamer bodies, rotary table shafting, oil well tool joints, spindles, stay bolts, tractor axles, tractor arms, axle shafts, valves, bolts, subs, couplings, trailer axles, winch shafts, piston rods, rams, hydraulic machinery shafts, precision lead screws, chain links, zinc die-casting dies.

TREATMENT(S):

The Mobius part this material is used in is liquid nitrided and black oxidized.

| CHEMICAL COMPOSITION (% NOMINAL) | | MECHANICAL PROPERTIES | |
|----------------------------------|----------------|--|------------|
| C | 0.38/0.43 Max. | Tensile Strength | 70,000 PSI |
| Mn | 0.75/1.00 | Yield Point | 60,000 PSI |
| P | 0.035 Max. | Elongation*** | 20 |
| S | 0.04 Max. | Brinell Hardness | 200 |
| Si | 0.15/0.35 | ** Ranges shown are for 4140 Annealed. All values are minimum values and are representative. | |
| Cr | 0.80/1.10 | *** % in 2" | |
| Mo | 0.15/0.25 | | |

* Chemical Analysis will vary on each heat number.

CARBON STEEL 1045 CR

USED IN:

Helical Blade Shaft

Carbon steel 1045 is designed to be able to function in areas requiring greater strength and hardness. This steel possesses excellent size accuracy, concentricity, and straightness which together enable to minimize wear in high speed applications.

TYPICAL APPLICATIONS:

Typical uses include gears, shafts, axles, bolts, studs, and machine parts.

TREATMENT(S):

The Mobius part this material is used in is liquid nitrided and black oxidized.

| CHEMICAL COMPOSITION (% NOMINAL) | | MECHANICAL PROPERTIES | |
|----------------------------------|-------------|-----------------------|------------|
| C | 0.42 - 0.50 | Tensile Strength | 90,600 PSI |
| Mn | 0.60 - 0.90 | Yield Point | 73,900 PSI |
| P | 0.040 Max. | Elongation*** | 12% |
| S | 0.050 Max. | Brinell Hardness | 179 |

* Chemical Analysis will vary on each heat number.

UHB SS716 STAINLESS STEEL

USED IN:

Bed Knife Cutting Edge

DESCRIPTION:

UHB SS716 is a cold rolled martensitic stainless steel grade designed for applications where toughness and impact fatigue strength are essential (even at temperatures as high as 400°C). The 13% chromium steel is delivered in the hardened and tempered condition and has proven to offer exceptional bending and impact fatigue properties and good corrosion resistance.

TYPICAL APPLICATIONS:

Surgical blades, culinary knives, assembly parts, motor parts.

CHEMICAL COMPOSITION (% NOMINAL)

| | |
|-------|-------|
| C | 0.38 |
| Mn | 0.55 |
| P max | 0.025 |
| S max | 0.015 |
| Si | 0.45 |
| Cr | 13.5 |
| Mo | 1.00 |

PHYSICAL PROPERTIES

| | |
|---|----------------------------------|
| Density, ρ | 7.7 g/cm ³ |
| Thermal Expansion, <100°C (210°F) | 10.6 x 10 ⁻⁶ /°C |
| Thermal Conductivity, RT | 24 W/m °C |
| Specific Heat Capacity, RT to 100°C (210°F) | 460 j/kg °C |
| Resistivity, RT | 0.75 Ω mm ² /m |
| Damping loss factor, (215 Hz, <150°C) | 0.0011 |

MECHANICAL PROPERTIES

| | |
|-----------------------------------|----------|
| Ultimate Tensile Strength, Rm | 1810 MPa |
| Proof Strength, Rp _{0.2} | 1450 MPa |
| Elongation, A ₅₀ | 4-6 % |
| Modulus of Elasticity | 210 GPa |
| Hardness | 540 HV |

FATIGUE PROPERTIES

| | |
|--|--------------|
| Tensile Fatigue Limit Ratio, σ_u / R_m , (20°C) | 0.33 |
| Bending Fatigue Limit Ratio, σ_u / R_m , (20°C) | 0.35 |
| Compressive residual stresses | -350±100 MPa |

316 STAINLESS STEEL CABLE

USED IN:

Wire Tumbler Body

DESCRIPTION:

Stainless steel Type 316 is an Austenitic alloy that was developed for added corrosion resistance, when compared to other stainless steels (e.g. Type 304). It generally has a slightly higher nickel content but is distinguished by the addition of molybdenum.

TYPICAL APPLICATIONS:

Often used in marine environments and refrigeration applications, where corrosion resistance is key. General grade for food processing, chemical storage and transport, textile dyeing equipment, cladding of nuclear fuel, and oil refining equipment as well as some medical implants.

CHEMICAL COMPOSITION (% NOMINAL)

| | |
|----|-----------|
| Cr | 16 – 18 |
| Ni | 10 – 14 |
| C | 0.08 |
| Mn | 2 |
| Si | 0.75 |
| P | 0.045 |
| S | 0.03 |
| N | 0.10 |
| Mo | 2.0 – 3.0 |

OTHER PROPERTIES

| | |
|------------------------|--------------------------------|
| Type | Aircraft Cable |
| Type Description | Strand |
| Application | Commercial |
| Strand Construction | 1 x 7 |
| Material | Pre-formed 316 Stainless Steel |
| Diameter | $\frac{1}{32}$ Inch |
| Minimum Break Strength | 150 lbs. / 68.03 kg |
| Coating | Bare |

304 STAINLESS STEEL

USED IN:

Brush Shaft, Separator Housing

DESCRIPTION:

Stainless steel Type 304 is a commonly used form stainless steel that demonstrates excellent corrosion resistance to most oxidizing acids and is easy to sanitize.

TYPICAL APPLICATIONS:

Kitchen and food applications.

CHEMICAL COMPOSITION (% NOMINAL)

| | |
|-------|---------|
| C | 0.08 |
| Mn | 2 |
| P max | 0.045 |
| S max | 0.03 |
| Si | 1 |
| Cr | 18 – 20 |

MECHANICAL PROPERTIES

| | |
|------------------------|--------|
| Tensile Strength | 85 ksi |
| Yield Strength | 35 ksi |
| Elongation in 2 Inches | 55% |
| Reduction of Area | 70% |
| Brinell Hardness | 150 |

PHYSICAL PROPERTIES

| | |
|--|------|
| Density Lb/In ³ | 0.29 |
| Coefficient of Thermal Expansion 32 – 212°F x 10 ⁻⁶ per °F | 9.6 |
| Specific Heat 32 – 212°F BTU/°F/Lb | 0.12 |
| Thermal Conductivity at 212 °F BTU/Ft/Ft ² /Hr/°F | 9.4 |
| Electrical Resistivity at 70°F Microhm-cm | 70 |

3003-H14 ALUMINUM

USED IN:

Aluminum Honeycomb Screens on Lid Assembly

DESCRIPTION:

General purpose, moderate strength, good workability and weldability, high resistance to corrosion.

TYPICAL APPLICATIONS:

Grilles and guards, architectural and decorative applications, cooking utensils, panels, railings, storage tanks.

TREATMENT(S):

The Mobius parts this material is used in are anodized.

CHEMICAL COMPOSITION (% NOMINAL)

| | |
|----|-------------|
| Si | 0.6 |
| Fe | 0.7 |
| Cu | 0.05 – 0.20 |
| Mn | 1.0 – 1.5 |
| Mg | – |
| Cr | – |
| Zn | 0.10 |
| Ti | – |

MECHANICAL PROPERTIES

| | |
|--|--|
| Tensile Strength (ksi) | Ultimate: 22 Yield: 21 |
| Elongation % in 2" Specimen | $\frac{1}{16}$ " thick: 8 $\frac{1}{2}$ " diam.: 16 |
| Brinell Hardness 500 Kg Load 10 mm Ball | 40 |
| Ultimate Shearing Strength (ksi) | 14 |
| Fatigue Endurance Limit (ksi) | 9 |
| Modulus of Elasticity (ksi x 103) | 10.0 |

PHYSICAL PROPERTIES

| | |
|---|---------------------------------------|
| Density Lb/In ³ | 0.099 |
| Avg. Coefficient of Thermal Expansion 68 to 212°F x 10 ⁻⁶ per °F | 12.9 |
| Melting Range Approximate °F | 1190 – 1210 |
| Temper | H14 |
| Thermal Conductivity at 77 °F BTU/Ft/Ft ² /Hr/°F | 92 |
| Electrical Conductivity at 68°F Percent of Int'l Annealed Cu Standard | Equal Volume: 41 Equal Weight: 134 |
| Electrical Resistivity at 68°F Ohms-Cir/Mil/Ft | 25 |

5052 ALUMINUM (H32)

USED IN:

Aluminum Flat Plates and Sheet Metal Parts (Mobius Body Tray and Impeller Housing)

DESCRIPTION:

Excellent resistance to salt water corrosion, good weldability and workability, good finishing characteristics.

TYPICAL APPLICATIONS:

Home appliances, vehicle bodies, small boats, sheet metal parts, fan blades.

TREATMENT(S):

The Mobius parts this material is used in are anodized.

CHEMICAL COMPOSITION (% NOMINAL)

| | |
|----|-------------|
| Si | 0.25 |
| Fe | 0.40 |
| Cu | 0.10 |
| Mn | 0.10 |
| Mg | 2.2 – 2.8 |
| Cr | 0.15 – 0.35 |
| Zn | 0.10 |
| Ti | – |

MECHANICAL PROPERTIES

| | |
|--|-----------------------------------|
| Tensile Strength (ksi) | Ultimate: 35 Yield: 28 |
| Elongation % in 2" Specimen | 1/16" thick: 12 1/2" diam.: 18 |
| Brinell Hardness 500 Kg Load 10 mm Ball | 60 |
| Ultimate Shearing Strength (ksi) | 20 |
| Fatigue Endurance Limit (ksi) | 17 |
| Modulus of Elasticity (ksi x 10 ³) | 10.2 |

PHYSICAL PROPERTIES

| | |
|---|---------------------------------------|
| Density Lb/In ³ | 0.097 |
| Avg. Coefficient of Thermal Expansion 68 to 212°F x 10 ⁻⁶ per °F | 13.2 |
| Melting Range Approximate of | 1125 – 1200 |
| Thermal Conductivity at 77 °F BTU/Ft/Ft ² /Hr/°F | 80 |
| Electrical Conductivity at 68°F Percent of Int'l Annealed Cu Standard | Equal Volume: 35 Equal Weight: 116 |
| Electrical Resistivity at 68°F Ohms-Cir/Mil/Ft | 30 |

6063 ALUMINUM (T6)

USED IN:

Aluminum Extrusion Parts (Lid Extrusions, Bed Knife Bar, Spacer Bar and Impeller Housing)

DESCRIPTION:

Solution heat treated, then artificially aged. High corrosion resistance, medium strength, good natural finish.

TYPICAL APPLICATIONS:

Irrigation pipe, store fronts, architectural trim, pipe railing, furniture.

TREATMENT(S):

The Mobius parts this material is used in are anodized or powder coated.

| CHEMICAL COMPOSITION (% NOMINAL) | | MECHANICAL PROPERTIES | |
|----------------------------------|------------|--|---------------------------|
| Si | 0.20 – 0.6 | Tensile Strength (ksi) | Ultimate: 35 Yield: 31 |
| Fe | 0.35 | Elongation % in 2 in. 1/16 in. Thick Specimen | 12 |
| Cu | 0.10 | Brinell Hardness 500 Kg Load 10 mm Ball | 73 |
| Mn | 0.10 | Ultimate Shearing Strength (ksi) | 22 |
| Mg | 0.45 – 0.9 | Fatigue Endurance Limit (ksi) | 10 |
| Cr | 0.10 | Modulus of Elasticity (ksi x 10 ³) | 10.0 |
| Zn | 0.10 | | |
| Ti | 0.10 | | |

PHYSICAL PROPERTIES

| | |
|---|---------------------------------------|
| Density Lb/In ³ | 0.097 |
| Avg. Coefficient of Thermal Expansion 68 to 212°F x 10 ⁻⁶ per °F | 13.0 |
| Melting Range Approximate °F | 1140 – 1210 |
| Temper | T6 |
| Thermal Conductivity at 77 °F BTU/Ft ² /Hr/°F | 116 |
| Electrical Conductivity at 68°F Percent of Int'l Annealed Cu Standard | Equal Volume: 53 Equal Weight: 175 |
| Electrical Resistivity at 68°F Ohms-Cir/Mil/Ft | 20 |

HARDENED & COATED POLYCARBONATE (LEXAN™ MR10)

USED IN:

Transparent Top Lid Shield and Trim Tote Window

DESCRIPTION:

LEXAN™ MR10 sheets are transparent polycarbonate sheets, coated on both sides to be both Mar and UV-resistant.

TYPICAL APPLICATIONS:

Transparent surfaces on equipment, furniture and finishes in high-traffic areas.

MECHANICAL PROPERTIES

| | |
|---|----------------------------------|
| Tensile Strength, Ultimate | 9,500 psi |
| Flexural Strength | 13,500 psi |
| Flexural Endurance @ 1,800 Cycles/Min, 73°F, 50% RH | 1,000 psi |
| Compressive Strength | 12,500 psi |
| Modulus of Elasticity | 345,000 psi |
| Drop Ball Impact Strength | >200 ft-lbs at all temps. tested |

PHYSICAL PROPERTIES

| | |
|---------------------------------------|---|
| Specific Gravity | 1.20 |
| Light Transmission (avg.), 1/8" thick | 88% |
| Chemical Resistance | Gasoline and kerosene: No tackiness, crazing or loss of transparency for a minimum of 48 hours. |

THERMAL PROPERTIES

| | |
|----------------------------------|----------------------------------|
| Coefficient of Thermal Expansion | 3.75 x 10 ⁻⁵ in/in/°F |
| Heat Deflection Temp. @ 264 psi | 270°F |

FLAMMABILITY

| | |
|--------------------------------|-------------------------------|
| Horizontal Burn (Flame Spread) | <1 in |
| Ignition Temperature | Flash: 873°F Self: 1,076°F |

TRITAN™ COPOLYESTER TX1501HF

USED IN:

Tumbler End Caps – Versions E and later

DESCRIPTION:

Eastman Tritan™ copolyester TX1501HF contains a mold release derived from vegetable-based sources. Outstanding features include good toughness, hydrolytic stability, and heat and chemical resistance. Tritan™ copolyester TX1501HF may be used in repeated use food contact articles under US FDA regulations and is certified to NSF/ANSI Standard 51 for Food Equipment Materials and to NSF/ANSI Standard 61 - Drinking Water System Components-Health Effects.

TYPICAL APPLICATIONS:

Appliances, baby bottles, auto plastics, consumer electronics, housewares, tools, toys, water bottles.

PHYSICAL PROPERTIES

| | |
|------------------|--|
| Specific Gravity | 1.18 |
| Mold Shrinkage | 0.005 - 0.007 mm / mm (0.005 - 0.007 in. / in.) |

THERMAL PROPERTIES

| | |
|------------------------|--------------|
| Deflection Temperature | |
| @ 0.455 MPa (66 psi) | 94°C (201°F) |
| @ 1.82 MPa (264 psi) | 81°C (178°F) |

MECHANICAL PROPERTIES

| | |
|---|---------------------------------------|
| Tensile Stress @ Yield | 43 MPa (6200 psi) |
| Tensile Stress @ Break | 52 MPa (7500 psi) |
| Elongation @ Yield | 7% |
| Elongation @ Break | 210% |
| Tensile Modulus | 1575 MPa (2.28 x 10 ⁵ psi) |
| Flexural Modulus | 1575 MPa (2.28 x 10 ⁵ psi) |
| Flexural Yield Strength | 64 MPa (9300 psi) |
| Rockwell Hardness, R Scale | 111 |
| Izod Impact Strength, Notched @ 23°C (73°F) | 860 J/m (16.1 ft·lbf/in.) |
| Impact Strength, Unnotched @ 23°C (73°F) | NB |

BASF ULTRAMID® 8202C POLYAMIDE 6

USED IN:

Tumbler Rings

DESCRIPTION:

Ultramid 8202C is a modified crystalline and low viscosity PA6 injection molding homopolymer. Its crystalline structure results in increased strength, stiffness, heat distortion temperature and performance under load as a homopolymer

TYPICAL APPLICATIONS:

Furniture casters, gears, window hardware and fittings, insulators, valves, relays, wiring devices and other electrical components.

| | PROPERTIES |
|------------------------------|--------------|
| Melt Temperature | 240 – 285 °C |
| Mold Temperature | 65 – 80 °C |
| Injection & Packing Pressure | 35 – 125 bar |

DUPONT TYNEX® A 612 NYLON

USED IN:

Brush Bristles

DESCRIPTION:

Tynex® A is an abrasive filament made by extruding a mixture of nylon and abrasive grit. Nylon has several characteristics that make it attractive for abrasive filaments. Nylon is tougher and more durable than common alternative polymers. It is also resistant to abrasion, a fact that helps extend its useful life.

TYPICAL APPLICATIONS:

Industrial brushes for cleaning and equipment applications.

PHYSICAL PROPERTIES

| | |
|---------------------------|----------|
| Melting Point | > 200 °C |
| Decomposition Temperature | > 190 °C |

HDPE (HIGH-DENSITY POLYETHYLENE)

USED IN:

Trim Tote

DESCRIPTION:

Flexible, translucent/waxy, weatherproof, good low temperature toughness (to -60°C), easy to process by most methods, good chemical resistance.

TYPICAL APPLICATIONS:

Food storage containers, piping, plastic bottles, geomembranes, fuel tanks.

| PROPERTIES | |
|----------------------------------|---------------------------------|
| Tensile Strength | 0.20 – 0.40 N/mm ² |
| Notched Impact Strength | No break |
| Thermal Coefficient of Expansion | 100 – 200 x 10 ⁻⁶ |
| Max. Continued Use Temp. | 65°C (149°F) |
| Melting Point | 126°C (259°F) |
| Density | 0.941 – 0.965 g/cm ³ |

CLOSED CELL EPDM SPONGE RUBBER

USED IN:

Trim Tote Gasket/Seal

DESCRIPTION:

Exhibits very good aging properties, compressibility, and shows an excellent resistance to UV, ozone and oxidation.

TYPICAL APPLICATIONS:

Various industrial and commercial applications such as HVAC systems, automotive parts and electrical enclosures.

| PROPERTIES | |
|--|-----------|
| Density | 0.65 |
| Compression Deflection (CD) to 25% | 0.052 MPa |
| Heat Resistance (% change from original CD value after oven-aged 7 days @ 70°C | -3.9% |
| Compression Set 22 hrs. @ 70°C, 50% deflection with 30 min. recovery | 24.6% |
| Compression Set 22 hrs. @ 70°C, 50% deflection with 24 hr. recovery | 18.5% |
| Compression Set 22 hrs. @ 23°C, 50% deflection with 24 hr. recovery | 5.2% |
| Fungus Resistance | Pass |

EA E-30CL ADHESIVE

USED IN:

Bed Knife Assembly

DESCRIPTION:

LOCTITE® EA E-30CL, also known as Hysol E-30CL Epoxy ADH Ultra, is a clear, colorless to slightly yellowish, 2-part, low viscosity, industrial grade epoxy adhesive. It cures at room temperature with minor shrinkage to form an ultra clear adhesive bondline with excellent impact resistance. It resists a wide range of chemicals and solvents and bonds most materials including glass, optical fibers, ceramics, metals and many rigid plastics.

TYPICAL APPLICATIONS:

Used in bonding, small potting, staking and laminating applications where optical clarity and excellent structural, mechanical and electrical insulating properties are required

| PROPERTIES | |
|-----------------------------|--|
| Cure Type | Room Temperature Cure |
| Fixture Time | 3 hours |
| Full Cure Temperature (°C) | 25 |
| Full Cure Temperature (°F) | 77 |
| Full Cure Time | 24 hours |
| Key Characteristics | Chemical Resistant, Impact Resistant, Performance: High Performance, Viscosity: Low Viscosity, Work Life: Medium Work Life |
| Number of Components | 2 Part |
| Shear Strength, Steel (psi) | 3100 |
| Technology | Epoxy |
| Substrates | Ceramic, Metal, Plastic |

ABS (ACRYLONITRILE BUTADIENE STYRENE) PLASTIC

USED IN:

Input Hopper & Output Chute

DESCRIPTION:

Acrylonitrile Butadiene Styrene (ABS) is an opaque thermoplastic and amorphous polymer. ABS plastics can be heated to their melting point, cooled, and re-heated again without significant degradation. Instead of burning, thermoplastics like ABS liquefy which allows them to be easily injection molded and then subsequently recycled.

TYPICAL APPLICATIONS:

Power-tool housings, home décor applications, toys

| | PROPERTIES |
|----------------------|--|
| Tensile Strength | 450 kg/cm ² |
| Flexural Strength | 820 kg/cm ² |
| Flexural Modulus | 31,000 kg/cm ² |
| Rockwell Hardness | R-108 |
| Izod Impact Strength | 1/4" bar: 25 kg-cm/cm 1/8" bar: 29 kg-cm/cm |
| Heat Deflection | 85°C |
| Melt Flow | 21 g/10 min |
| Specific Gravity | 1.05 |