



EXOTIC MATERIAL GRADE CHART

Complete guide to exotic & high-performance alloys for industrial fasteners

Inconel · Hastelloy · Monel · Titanium · Duplex · Incoloy · Aluminium · PTFE · PEEK

Chemical composition · Mechanical properties · Corrosion resistance · Application guide

2025 – 2026 EDITION

NICKEL ALLOYS

Inconel · Incoloy · Hastelloy

TITANIUM

Grade 2 · Grade 5 (Ti-6Al-4V)

COPPER ALLOYS

Brass C360 · Monel 400 · Naval

ENGINEERING POLYMERS

PTFE · PEEK · Nylon · POM

COBALT ALLOYS

Monel · Stellite

DUPLEX / S.DUPLEX

2205 · 2507 · Zeron 100

ALUMINIUM ALLOYS

2024 · 6061 · 7075

COBALT-CHROME

Stellite 6 · Stellite 21

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Inconel & Incoloy — Nickel-Chromium Superalloys

High-temperature strength · Oxidation resistance · Creep resistance · Aerospace & chemical plant

Inconel alloys are nickel-chromium superalloys that maintain exceptional strength at temperatures up to 1100°C. The chromium and molybdenum content provides outstanding oxidation and corrosion resistance. Widely used in gas turbines, aerospace, subsea equipment, chemical processing and nuclear

Alloy / UNS	Ni%	Cr%	Mo%	Fe%	Other	Tensile (MPa)	Yield (MPa)	Hardness (HRB)	Max Temp (°C)	ASTM Spec
Inconel 600 UNS N06600	72+	14–17	—	6–10	Mn 1.0 max	655	310	— (ductile)	1175	B166/B167
Inconel 601 UNS N06601	58–63	21–25	—	Bal	Al 1.0–1.7	795	310	—	1230	B166/B168
Inconel 625 UNS N06625	58+	20–23	8–10	5	Nb 3.15–4.15	827	414	—	980	B446/B444
Inconel 718 UNS N07718	50–55	17–21	2.8–3.3	Bal	Nb 4.75–5.5	1275	1034	40 HRC	700	B637/AMS5662
Inconel 800 UNS N08800	30–35	19–23	—	Bal	Al 0.15–0.6	517	207	—	980	B409/B407
Inconel 825 UNS N08825	38–40	9.5–23	2.5–3.5	Bal	Ti 0.6–1.2	586	241	—	540	B425/B423
Inconel 925 UNS N09925	38–40	9.5–23	2.5–3.5	Bal	Ti+Al age hard.	1000	827	—	300	—
Incoloy 800H UNS N08810	30–35	19–23	—	Bal	C 0.05–0.10	450	170	—	1000	B409
Incoloy 925 UNS N09925	42–44	9.5–23	2.5–3.5	22	Age hardened	1034	862	—	350	B805

Hastelloy — Nickel-Molybdenum-Chromium Alloys

Outstanding resistance to strong acids · Chemical processing · FGD systems · Pharmaceutical · Pulp & paper

Hastelloy alloys are nickel-molybdenum-chromium superalloys engineered for exceptional resistance to both oxidising and reducing environments, including strong acids such as HCl, H₂SO₄ and HF. Widely used where no other alloy system provides adequate corrosion protection.

Alloy / UNS	Ni%	Cr%	Mo%	Fe%	W%	Co%	Tensile (MPa)	Yield (MPa)	Max Temp (°C)	PREN*	Best Environment
Hastelloy B-2 N10665	69	1.0	28	2.0	—	—	758	345	870	—	HCl, H ₂ SO ₄ (reducing)
Hastelloy B-3 N10675	65	1.0	28.5	1.5	3.0 / 3.0	—	760	370	870	—	HCl without oxidants
Hastelloy C-4 N06455	Bal	16	15	3.0	—	—	785	370	1040	65	Oxidising+reducing mix
Hastelloy C-22 N06022	Bal	22	13	3.0	3.0 / 2.5	—	690	310	1040	65	Oxidising acid mix
Hastelloy C-276 N10276	Bal	15.5	16	5.5	3.75 / 2.5	—	690	283	1040	69	Broadest corr. resist.
Hastelloy C-2000 N06200	Bal	23	16	3.0	—	—	740	350	1040	73	HNO ₃ + HCl combined
Hastelloy G-30 N06030	Bal	30	5.5	15	2.5 / 5.0	—	690	310	980	56	Phosphoric acid
Hastelloy N N10003	Bal	7.0	16	5.0	—	—	815	360	1000	—	Molten fluoride salts
Hastelloy S N06635	Bal	15.5	14.5	3.0	2.0 / —	—	760	345	1095	—	High-temp oxidation
Hastelloy W N10004	Bal	5.0	24.5	5.5	—	—	780	340	1080	—	High-temp hot corrosion
Hastelloy X N06002	Bal	22	9.0	18.5	0.6 / 1.5	—	655	255	1175	—	Gas turbine combustion

*PREN = Pitting Resistance Equivalent Number = %Cr + 3.3×%Mo + 30×%N. Higher = better pitting resistance.

C-276 is the most widely used Hastelloy grade — broadest corrosion resistance across oxidising + reducing environments.

Monel — Nickel-Copper Alloys

Marine & seawater service · Brine systems · HF acid resistance · Offshore & subsea

Monel alloys are nickel-copper alloys (67% Ni, 30% Cu) offering outstanding corrosion resistance in seawater, brine and hydrofluoric acid. The K-500 grade is precipitation-hardened for much higher strength than Monel 400, making it ideal for marine fasteners and pump shafts.

Alloy / UNS	Ni%	Cu%	Fe%	Mn%	Other	Tensile (MPa)	Yield (MPa)	Elong. (%)	Max Temp (°C)	Application
Monel 400 N04400	63–70	Bal	2.5	2.0	S 0.024	550	240	35	480	Marine, seawater, valves
Monel 401 N04401	40–44	Bal	0.75	2.25	—	480	170	35	400	Low expansion alloy
Monel 404 N04404	52–57	Bal	0.5	0.1	—	483	172	35	450	Electronics, hermetic seals
Monel 405 N04405	63–70	Bal	2.5	2.0	S 0.025–0.060	517	207	25	450	Free-machining, screws
Monel K-500 N05500	63–70	Bal	2.0	Al 2.3–3.15	Ti 0.35	1000	690	20	480	High-str. marine fasteners
Monel 502 N05502	63–70	Bal	2.0	1.5	Al 2.5–3.5	827	517	25	400	Valve components

MONEL 400 vs SS 316 — CORROSION RESISTANCE COMPARISON

Environment / Service	Monel 400 Performance	SS 316 Performance
Seawater (ambient)	Excellent	Good
Seawater (hot > 60°C)	Excellent	Limited — crevice corrosion
HF (hydrofluoric) acid	Excellent	Unacceptable
HCl dilute	Good	Limited
H2SO4 dilute	Good	Good
Caustic NaOH	Excellent	Good
Brine / salt solutions	Excellent	Good
Chloride stress corrosion	Resistant	Susceptible
Cost vs CS	High (x8–12)	Moderate (x3–5)

Titanium Alloys — All Grades

Unmatched strength-to-weight ratio · Excellent corrosion resistance · Biocompatible · Aerospace & marine

Titanium is 45% lighter than steel yet stronger than most aluminium alloys, with outstanding corrosion resistance in seawater, chloride and oxidising environments. Grade 2 is the standard corrosion-resistant pure titanium. Grade 5 (Ti-6Al-4V) is the aerospace workhorse — highest strength Ti alloy. Titanium fasteners are used in aerospace, offshore, medical, desalination, chemical and demanding structural applications.

Grade / UNS	Type	O2% (max)	N2% (max)	Al%	V%	Other	Tensile (MPa)	Yield (MPa)	Elong. (%)	Density (g/cc)	ASTM Spec	Application
Grade 1 R50250	Pure Ti — softest	0.18	0.03	—	—	—	240	170	24	4.51	B265/B348	Chemical, medical, dental
Grade 2 R50400	Pure Ti — standard	0.25	0.03	—	—	—	345	275	20	4.51	B265/B348	Fasteners, marine, chemical
Grade 3 R50550	Pure Ti — medium	0.35	0.05	—	—	—	450	380	18	4.51	B265/B348	Structural, moderate strength
Grade 4 R50700	Pure Ti — strongest	0.40	0.05	—	—	—	550	483	15	4.51	B265/B348	High-str. pure Ti, chem.
Grade 5 R56400	Ti-6Al-4V ($\alpha+\beta$)	0.20	0.05	5.5–6.5	3.5–4.5	V	950	880	10	4.43	B265/B348	Aerospace, offshore, racing
Grade 6 R54520	Ti-5Al-2.5Sn	0.20	0.05	4.0–6.0	—	Sn 2–3	830	790	10	4.48	B265	Cryogenic, aircraft
Grade 7 R52400	Ti-0.15Pd	0.25	0.03	—	0.12–0.25	Pd	345	275	20	4.51	B265/B348	Reducing acid resist.
Grade 9 R56320	Ti-3Al-2.5V	0.15	0.03	2.5–3.5	1.5–2.5	V	620	483	15	4.48	B338	Tubing, hydraulic lines
Grade 11 R52250	Ti-0.15Pd (low C)	0.18	0.03	—	0.12–0.25	Pd	240	170	24	4.51	B265	Seawater + acid dual
Grade 12 R53400	Ti-0.3Mo-0.8Ni	0.25	0.03	—	0.8 Ni, 0.3 Mo	—	480	380	18	4.51	B265/B338	HCl+H2SO4 environments
Grade 23 R56407	Ti-6Al-4V ELI	0.13	0.05	5.5–6.5	3.5–4.5	V	828	759	10	4.43	F136	Medical implants — ELI
Grade 29 R56404	Ti-6Al-4V-0.1Ru	0.13	0.05	5.5–6.5	3.5–4.5	V+Ru	828	759	10	4.43	—	Offshore — best Ti alloy

Duplex & Super Duplex Stainless Steel

Combined ferritic-austenitic microstructure · High strength · Chloride resistance · PREN > 40 for seawater

Duplex grades combine austenitic and ferritic microstructures, delivering 2x the strength of standard austenitic SS and superior chloride pitting and crevice corrosion resistance. PREN > 40 (Super Duplex) recommended for seawater service. Widely used in offshore, subsea and desalination.

Formula: PREN = %Cr + 3.3x%Mo + 16x%N · Duplex PREN 30–40 · Super Duplex PREN > 40

Grade / UNS	Cr%	Ni%	Mo%	N%	W%	Cu%	Tensile (MPa)	Yield (MPa)	PREN	Max Cl [■] (ppm)	ASTM Spec	Application
Duplex 2304 S32304	23	4.5	0.3	0.10	—	—	620	400	26	200	A182/A240	Low-chloride environments
Duplex 2205 S31803	22	5.5	3.2	0.16	—	—	620	450	35	1000	A182/A240	Standard duplex — workhorse
Duplex 2205 S32205	22	5.5	3.2	0.17	—	—	655	450	35	1000	A182/A240	Updated 2205 — higher N
Duplex 2209 S32209	22	6.5	3.2	0.20	—	—	660	460	37	1500	—	High-N enhanced
S.Duplex 2507 S32750	25	7.0	4.0	0.27	—	—	800	550	43	5000	A182/A240	Seawater, offshore, desalination
S.Duplex 2507 S32760	25	7.0	3.7	0.22	0.5	0.7	750	550	42	4000	A182/A240	Offshore — alternate spec
Zeron 100 S32760	25	7.0	3.5	0.22	0.7	0.7	750	550	41	4000	A890	Pumps, valves, offshore
DP3W S39274	25	7.0	4.0	0.24	2.0	—	780	560	41	4000	—	High-W version
Hyper Duplex 33 S33207	33	6.5	4.0	0.40	—	0.8	900	600	49	10000+	—	Extreme chloride environments
SAF 2906 S32906	29	6.5	2.5	0.40	—	0.8	750	530	42	3000	—	High-Cr lean super duplex

PREN colour guide: GREEN = Standard Duplex (PREN 25–39) · GOLD = Super Duplex (PREN 40–42) · RED = Hyper Duplex (PREN > 43)
 Max Cl[■] = maximum chloride concentration for corrosion-free service (indicative values only — temperature, pH and flow affect actual limits).

Copper Alloys — Brass, Bronze & Pure Copper

Electrical conductivity · Machinability · Marine corrosion resistance · Non-sparking · Non-magnetic

Copper alloys offer excellent electrical conductivity, machinability and corrosion resistance. Brass (Cu-Zn) and Bronze (Cu-Sn) are widely used for fasteners in electrical, plumbing, marine and instrument applications. Non-sparking properties essential for oil & gas hazardous area hardware.

Alloy / UNS	Cu%	Zn%	Sn%	Pb%	Ni%	Al%	Tensile (MPa)	Yield (MPa)	Conduct. (%IACS)	Density (g/cc)	Key Property	Application
Brass C260 (Cartridge)	70	30	—	—	—	—	345	100	28	8.53	Deep drawing	Electrical, instrument parts
Brass C330 (Low Lead)	66	33.5	—	0.35	—	—	370	130	27	8.50	General machining	Plumbing fittings, fasteners
Brass C360 (Free-machin.)	61.5	35.5	—	3.0	—	—	490	415	26	8.50	Best machinability	Screws, inserts, turned parts
Brass C385 (Arch. Brnz)	56	42	—	3.0	—	—	380	140	26	8.50	Casting alloy	Decorative hardware, handles
Brass C464 (Naval Brass)	60	39.25	0.75	—	—	—	380	170	26	8.52	Dezinc. resistant	Marine bolts, ship fittings
Brass C485 (Naval Brass)	60	37.5	0.75	1.75	—	—	400	180	26	8.52	Marine + machining	Offshore hardware, marine
Bronze C510 (Phos. Bronze)	95	—	5.0	—	—	—	500	200	18	8.86	Spring + corr.	Springs, clips, connectors
Bronze C630 (Al Bronze)	89	—	—	—	—	10	620	415	12	7.60	High strength	Gears, bushings, marine
Beryl. Bronze C172000	98	—	—	—	—	1.9	1250	1100	22	8.25	Highest Cu strength	Non-spark tools, springs
Copper C110 (Pure ETP)	99.9+	—	—	—	—	—	220	69	100	8.94	Max conductivity	Busbars, grounding bolts
Copper C122 (DHP)	99.9+	—	—	—	—	—	220	69	98	8.94	Weldable pure Cu	Plumbing, HVAC, heat exch.
Cupronickel 90/10 C70600	88	—	—	—	—	10	350	140	5	8.94	Marine corrosion	Seawater heat exchangers
Cupronickel 70/30 C71500	70	—	—	—	—	30	450	170	3	8.95	Best Cu seawater	Offshore, condensers

Aluminium Alloys — Fastener Grades

Lightweight · Non-magnetic · Non-sparking · Good corrosion resistance · Aerospace & structural

Aluminium fasteners are one-third the weight of steel, naturally corrosion resistant and non-magnetic. Used in aerospace, electronics, automotive and lightweight structural applications. Density 2.70 g/cc vs steel 7.85 g/cc — 65% weight reduction for same volume.

Alloy / Temper	Series	Si%	Mg%	Cu%	Zn%	Mn%	Tensile (MPa)	Yield (MPa)	Elong. (%)	Hardness (HB)	Density (g/cc)	Application
Al 2011-T3 Free-machining	2xxx	—	—	5.5	—	—	380	295	15	95	2.83	Turned screws, fasteners
Al 2024-T4 Aerospace	2xxx	—	1.5	4.0	—	0.6	470	325	19	120	2.78	Aircraft structural bolts
Al 2024-T351	2xxx	—	1.5	4.0	—	0.6	485	345	18	125	2.78	High-strength aerospace
Al 5052-H32 Marine	5xxx	—	2.5	—	—	—	230	160	12	60	2.68	Marine, corrosion service
Al 5083-H111	5xxx	—	4.5	—	—	0.7	290	145	16	75	2.66	Marine, pressure vessels
Al 6061-T6 General	6xxx	0.6	1.0	0.25	—	—	310	276	12	95	2.70	General structural fasteners
Al 6063-T5 Extrusion	6xxx	0.4	0.7	—	—	—	186	145	12	60	2.70	Architectural, trim
Al 6082-T6	6xxx	1.0	0.9	—	—	0.5	310	260	10	90	2.71	European structural fastener
Al 7075-T6 High-str.	7xxx	—	2.5	1.6	5.6	—	570	503	11	150	2.81	Highest-str. Al fasteners
Al 7050-T7451	7xxx	—	2.0	2.3	6.2	—	510	450	11	135	2.83	Aerospace thick plate
Al 7068-T6511	7xxx	—	2.5	2.0	7.2	—	683	621	9	170	2.85	Ultra-high strength Al
Al 7475-T761	7xxx	—	2.1	1.7	5.7	—	510	450	13	145	2.81	Aerospace — best toughness

Engineering Polymers — Fastener Grade Plastics

Non-conductive · Chemically inert · Lightweight · FDA compliant grades available · High-performance

Engineering polymers are used where metallic fasteners would cause galvanic corrosion, electrical conduction, magnetic interference or contamination. PEEK is the highest-performance thermoplastic — close to stainless steel in strength with full chemical resistance. PTFE is essentially inert to all chemicals.

Material	Type	Tensile (MPa)	Flex. Mod (GPa)	Max Cont. Temp (°C)	Chem. Resist.	Density (g/cc)	FDA Approved	Dielectric (MV/m)	Application
PTFE (Teflon®)	Fluoropolymer	14–35	0.5	260	Excellent — ir	2.20	Yes	60	Chemical seals, liners, gaskets
PVDF (Kynar®)	Fluoropolymer	50	2.0	150	Excellent	1.78	Yes	11	Chemical pipe fittings, seals
PEEK	Polyetheretherke	100	3.6	250	Excellent	1.32	Yes	—	Aerospace, medical, chemical
PEEK-GF30	PEEK + 30% gl	160	9.0	260	Excellent	1.51	Yes	—	High-load structural PEEK
Nylon 6 (PA6)	Polyamide	70	2.7	120	Good	1.13	—	—	General fasteners, inserts
Nylon 6.6 (PA66)	Polyamide	80	2.9	130	Good	1.14	Yes	—	Automotive, structural
Nylon 12 (PA12)	Polyamide	48	1.4	100	Good	1.01	—	—	Flexible, low moisture absorb
Delrin® (POM-H)	Polyacetal	65	2.9	120	Good	1.42	—	—	Precision gears, inserts
POM-C (Copolymer)	Polyacetal	62	2.7	110	Good	1.41	Yes	—	Food machinery, medical
Polycarbonate (PC)	Thermoplasti	65	2.4	130	Moderate	1.20	Yes	—	Transparent covers, lenses
UHMW-PE	Polyethylene	48	0.7	80	Excellent	0.93	Yes	—	Liners, chemical bearings
PPS (Ryton®)	Polyphenylenesul	90	3.8	220	Excellent	1.35	—	—	High-temp chemical service
PVDF / Polyvinyliden	Fluoropolymer	55	2.0	150	Excellent	1.78	Yes	—	Chemical, pharmaceutical
Torlon® (PAI)	Polyamide-imid	190	5.0	260	Excellent	1.38	—	—	Extreme-duty small fasteners

Exotic Material Selection Guide

Match your service environment to the correct exotic alloy — quick reference for engineers & procurement

ENVIRONMENT-TO-MATERIAL SELECTION MATRIX

Service Environment	Recommended Material	ASTM Spec	Max Temp	Engineering Notes
High-temperature > 650°C (gas turbin	Inconel 625 / 718	AMS 5662	up to 1000°C	Age-hardenable 718 for highest strength
High-temperature 400–650°C (power p	Inconel 600 / 800H	B166/B409	up to 980°C	Oxidation & carburisation resistant
Seawater (offshore fasteners)	Super Duplex 2507 / Zeron 101	A182 F53	Ambient	PREN > 40 mandatory for seawater
Seawater (bolting — critical)	Monel K-500	B865	up to 480°C	High strength + crevice resistant
HCl / hydrochloric acid	Hastelloy B-2 / B-3	B333	up to 870°C	Best resistance to HCl at all concentrations
HCl + oxidants / mixed acids	Hastelloy C-276 / C-22	B574	up to 1040°C	Broadest corrosion resistance any alloy
H2SO4 / sulphuric acid (dilute)	Hastelloy B-2 or C-276	—	80°C max	Concentration dependent — check chart
HF / hydrofluoric acid	Monel 400	B164	up to 370°C	Monel 400 uniquely resistant to HF
Chloride stress corrosion cracking	Super Duplex 2507 / Inconel 62	A182	Ambient	Austenitic SS susceptible — avoid
Sour service H2S (NACE MR0175)	SS 316 NACE / Duplex 2205	A182	Ambient	Hardness < 22 HRC mandatory
Cryogenic service (< -100°C)	Incoloy 825 / SS 304L / Al	B423	-196°C	Must confirm impact toughness
Lightweight structural (aerospace)	Titanium Grade 5 (Ti-6Al-4V)	B348	up to 315°C	45% lighter than steel, same strength
Lightweight general (automotive / OE)	Aluminium 7075-T6	AMS2770	up to 150°C	Highest strength aluminium alloy
Chemical inertness (pharmaceutical)	PTFE / PEEK	FDA 21 CFR	up to 260°C	PEEK for structural, PTFE for seals
Non-sparking (hazardous areas)	Beryllium Bronze / Monel	ATEX	Ambient	Non-ferrous — no spark generation
Non-magnetic (MRI / sensors)	Titanium / Brass / PEEK	—	varies	No magnetic response
Phosphoric acid (fertiliser plant)	Hastelloy G-30	B582	up to 200°C	Specifically engineered for H3PO4
Nuclear / high-radiation service	Inconel 600 / 625	ASME III	up to 700°C	Radiation-stable microstructure

REQUEST EXOTIC ALLOY FASTENERS · MATERIAL TEST REPORTS · PMI TESTING · EN 10204 CERTIFICATION

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