

Ferro-Tic Grade C

GRADE DESCRIPTION

Ferro-Tic Grade C is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in a heat-treatable tool steel matrix. In the annealed state, it can be readily machined into any desired shape using conventional tooling. Grade C is used where ambient or working temperatures do not exceed 375°F.

APPLICATIONS

Ferro-Tic Grade C has been used effectively for all types of punching, stamping and piercing operations. Due to its ease of fabrication, high hardness and dimensional stability, Grade C is an excellent material for gage components. It has also been successfully used in cryogenic environments.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase			
Titanium Carbide	Cr	Mo	C	Fe
33.0	3.0	3.0	0.62	Bal

PROPERTIES

Density, g/cc.....	6.60
Hardness, Rc	
Annealed.....	44-52
Hardened and Tempered	68-71
Transverse Rupture Strength.....	216
(psi x 103)	
Compressive Strength.....	520
(psi x 103)	
Impact Strength.....	323
(charpy unnotched) (in-lbs/in ²)	
Tensile Strength.....	190
(psi x 103)	
Modulus of Elasticity, Mpsi	42
Coefficient of Thermal Expansion x 10 ⁻⁶ in/in/°F	
70°F-375°F.....	1.96
Linear Size Change	
Thru Heat Treatment, %.....	+0.048



ANNEALING

Use a slightly carburizing atmosphere or stainless steel envelope for protection.
Heat to 1550°F, hold for 3 hours
Cool to 1350°F, hold for 8 hours
Furnace cool to below 1200°F, air cool
Hardness 44 - 52 HRC
(Material is supplied in the annealed condition.)

HARDENING

Austenitizing Temperature:

1750°F Holding Time: 1 Hour per inch of thickness (minimum 30 minutes)

Austenitizing Method:

Protective Foil Envelope
Type 321 Stainless Steel Foil
.003 minimum thickness
Edges double crimped to prevent leakage

Air Quench:

Parts in protective envelope - start air flow (fan) over a heat sink plate

Remove pieces from envelope immediately after removing envelope from furnace, place pieces on heat sink

Tempering:

Should be done as soon as quenched parts reach 125°F
Hold parts for 1 hour at 375°F,
Air cool Hardness 68 -71 HRC

Ferro-Tic Grade CM

GRADE DESCRIPTION

Ferro-Tic Grade CM is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in a high carbon-high chromium tool steel matrix. In the annealed state, it can be readily machined into any desired shape using conventional tooling. Grade CM exhibits excellent wear resistance and will retain its hardness under prolonged use at temperatures up to 975°F.

APPLICATIONS

Ferro-Tic Grade CM is used for warm forming applications or wherever metal working or heavy friction could otherwise cause over-tempering or softening. Grade CM has been successfully used for screws, barrel liners and extrusion molding components in the plastics industry. It is also an excellent material for drawing and forming applications.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase			
	Cr	Mo	C	Fe
Titanium Carbide				
34.0	10.0	3.0	0.85	Bal

PROPERTIES

Density, g/cc.....	6.45
Hardness, Rc	
Annealed.....	46-52
Hardened and Tempered	66-71
Transverse Rupture Strength.....	185
(psi x 103)	
Compressive Strength.....	482
(psi x 103)	
Impact Strength.....	211
(charpy unnotched) (in-lbs/in ²)	
Tensile Strength.....	201
(psi x 103)	
Modulus of Elasticity, Mpsi	42
Coefficient of Thermal Expansion x 10 ⁻⁶ in/in/°F	
70°F-200°F.....	4.70
70°F-975°F.....	5.71
Linear Size Change	
Thru Heat Treatment, %.....	-0.0116



ANNEALING

Use a slightly carburizing atmosphere or stainless steel envelope for protection. Heat to 1650°F, hold for 3 hours

Cool to 1450°F, hold for 8 hours

Furnace cool to below 1200°F,

air cool Hardness 46 – 52 HRC

(material is supplied in the annealed condition)

HARDENING

Austenitizing Temperature:

1975°F Holding Time: 1 Hour per inch of thickness (minimum 30 minutes)

Austenitizing Method:

Protective Foil Envelope

Type 321 Stainless Steel Foil

.003 minimum thickness

Edges double crimped to prevent leakage

Air Quench:

Parts in protective envelope - start air flow (fan) over a heat sink plate remove pieces from envelope immediately after removing envelope from furnace, place pieces on heat sink

Vacuum Furnace

vacuum of 10 to 50 microns

Vacuum Quench: Positive pressure

quench (2 bar minimum) to below 125°F

Cold Treatment or Stabilization:

Must be done as soon as the quenched part reaches room temperature. Cool to -94°F or lower and hold for 1 hour per inch of cross section. Remove from cold treating unit and warm to room temperature. Temper immediately.

Tempering:

Should be done as soon as quenched parts reaches room temperature following the cold treatment. A double temper is required. Temper at 975°F, hold for 1 hour cool to room temperature Temper at 950°F, hold for 1 hour cool to room temperature Hardness 66 - 71 HRC

Ferro-Tic Grade SK

GRADE DESCRIPTION

Ferro-Tic Grade SK is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in a modified hot work, chromium tool steel matrix. In the annealed state, it can be readily machined into any desired shape using conventional tooling. SK is formulated to provide a combination of wear resistance, toughness and good thermal shock resistance.



APPLICATIONS

Ferro-Tic Grade SK is used in tooling applications where impact is encountered, or in hot work applications where thermal cycling is an issue. Specific applications include cold and hot heading dies, swaging dies, mandrels, hot work rolls, etc. SK is an excellent knife material especially in the plastics and packaging industries.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase				
	Cr	Mo	Ni	C	Fe
Titanium Carbide	5.0	4.0	0.5	0.4	Bal
25.0					

PROPERTIES

Density, g/cc.....6.80
Hardness, Rc
Annealed.....35-42
Hardened and Tempered
400°F Single Temper.....63-68
800°F Double Temper.....60-65
Transverse Rupture Strength.....225
(psi x 103)
Compressive Strength.....381
(psi x 103)
Impact Strength.....422
(Charpy unnotched) (in-lbs/in²)
Tensile Strength.....145
(psi x 103)
Modulus of Elasticity, Mpsi45
Coefficient of Thermal Expansion x 10⁻⁶ in/in/°F
70°F-200°F.....4.41
70°F-975°F.....5.89
Linear Size Change
Thru Heat Treatment, %.....+0.034
Thermal Shock Resistance.....100 cycles
(Heat to 1830°F, oil quench, repeat until crack appears)

ANNEALING

Use a slightly carburizing atmosphere or stainless steel envelope for protection.
Heat to 1550°F, hold for 3 hours
Cool to 1350°F, hold for 8 hours
Furnace cool to below 1200°F,
air cool Hardness 35 – 42 HRC
(material is supplied in the annealed condition)

HARDENING

Austenitizing Temperature:
1875°F Holding Time: 1 Hour per inch of thickness
(minimum 30 minutes)

Austenitizing Method:

Protective Foil Envelope
Type 321 Stainless Steel Foil
.003 minimum thickness
Edges double crimped to prevent leakage

Air Quench:

Parts in protective envelope – start air flow (fan) over a heat sink plate, remove pieces from envelope immediately after removing envelope from furnace, place pieces on heat sink

Vacuum Furnace

Vacuum of 10 to 50 microns
Vacuum Quench: Positive pressure quench (2 bar minimum) to below 125°F

Tempering:

Should be done as soon as quenched parts reach room temperature.
Cold Work: Temper at 400°F, hold for 1 hour, cool to room temperature
Hardness 63 – 68 HRC
Hot Work: Double temper at 800°F, hold for 1 hour, cool to room temperature
Hardness 60 - 65 HRC

Ferro-Tic Grade CS-40

GRADE DESCRIPTION

Ferro-Tic Grade CS-40 is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in a high chrome, martensitic stainless steel matrix. In the annealed state, it can be readily machined into any desired shape using conventional tooling. CS-40 exhibits excellent corrosion resistance to atmosphere, fresh water, mild organic acids and body acids. The high chromium content in the matrix provides increased hardenability, abrasive wear resistance and oxidation resistance over conventional stainless steels.



APPLICATIONS

Ferro-Tic Grade CS-40 is ideally suited for applications such as mechanical seal rings or tooling and equipment in the food processing and chemical industries. Because of its unique combination of wear resistance and corrosion resistance, Grade CS-40 has also found wide acceptance in the textile/fiber industry.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase			
	Cr	Mo	C	Fe
Titanium Carbide	Cr	Mo	C	Fe
35.0	20.0	0.5	0.8	Bal

PROPERTIES

Density, g/cc.....	6.45
Hardness, Rc	
Annealed.....	47-52
Hardened and Tempered.....	67-70
Transverse Rupture Strength.....	149
(psi x 103)	
Compressive Strength.....	453
(psi x 103)	
Impact Strength.....	148
(charpy unnotched) (in-lbs/in ²)	
Tensile Strength.....	145
(psi x 103)	
Modulus of Elasticity, Mpsi	45
Coefficient of Thermal Expansion x 10 ⁻⁶ in/in/°F	
70°F-200°F.....	0.00
70°F-700°F.....	2.45
Linear Size Change	
Thru Heat Treatment, %.....	+0.016

ANNEALING

Use a slightly carburizing atmosphere or stainless steel envelope for protection.
Heat to 1650°F, hold for 3 hours
Cool to 1450°F, hold for 8 hours
Furnace cool to below 1200°F, air cool
Hardness 47 – 52 HRC
(material is supplied in the annealed condition)

HARDENING

Austenitizing Temperature:

1875°F Holding Time: 1 Hour per inch of thickness
(minimum 30 minutes)

Austenitizing Method:

Protective Foil Envelope

Type 321 Stainless Steel Foil
.003 minimum thickness
Edges double crimped to prevent leakage

Air Quench:

Parts in protective envelope – start air flow (fan) over a heat sink plate, remove pieces from envelope immediately after removing envelope from furnace, place pieces on heat sink

Vacuum Furnace

Vacuum of 10 to 50 microns
Vacuum Quench: Positive pressure quench (2 bar minimum) to below 125°F

Tempering:

Should be done as soon as quenched parts reach room temperature.
Temper at 400°F, hold for 1 hour, cool to room temperature
Hardness 67 – 70 HRC

Ferro-Tic Grade MS-5A

GRADE DESCRIPTION

Ferro-Tic Grade MS-5A is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in an age-hardenable, martensitic stainless steel matrix. In the annealed state, it can be readily machined into any desired shape using conventional tooling. MS-5A exhibits excellent corrosion resistance due to the low carbon content in the chromium nickel precipitation hardening matrix.



APPLICATIONS

Ferro-Tic Grade MS-5A is ideally suited for applications in the food and chemical industries. MS-5A is widely used for pelletizer knives and die faces in the plastics industry.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase					
Titanium Carbide	Cr	Ni	Co	Mo	Ti	Fe
30.0	14.0	6.0	5.0	4.0	1.5	Bal

SOLUTION ANNEALING

Temperature: 1800°F for 1 Hour,
Rapid Cool, Approx. 52 HRC
(material is supplied in the solution annealed condition)

AGE HARDENING

Temperature: 900°F for 10 Hours,
Rapid Cool, 59-63 HRC

POPERTIES

Density, g/cc.....6.55
Hardness, Rc
Solution Annealed.....vApprox. 52
Aged.....59-63
Transverse Rupture Strength.....256
(psi x 103)
Compressive Strength.....415
(psi x 103)
Impact Strength.....343
(charpy unnotched) (in-lbs/in2)
Tensile Strength.....197
(psi x 103)
Modulus of Elasticity, Mpsi39
Coefficient of Thermal Expansion x 10⁻⁶ in/in/°F
70°F-212°F.....4.606
70°F-840°F.....5.471
Linear Size Change
Thru Heat Treatment, %.....-0.009

Ferro-Tic Grade PK

GRADE DESCRIPTION

Ferro-Tic Grade PK is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in an age-hardenable, maraging steel matrix. In the annealed state, it can be readily machined into any desired shape using conventional tooling. PK exhibits excellent corrosion resistance due to the low carbon content in the precipitation hardening matrix.



APPLICATIONS

Ferro-Tic Grade PK is especially suited for the plastics industry. Its unique combination of wear, heat, corrosion resistance and toughness make it an ideal material for pelletizing knives and die faces in polyethylene and polypropylene manufacturing.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase						
Titanium Carbide	Cr	Co	Mo	Cu	Al	Ti	Fe
30.0	15.0	9.0	6.0	0.8	0.75	0.6	Bal

SOLUTION ANNEALING

Temperature: 1650°F for 1 Hour,
Rapid Cool, Approx. 53 HRC
(material is supplied in the solution annealed condition)

AGE HARDENING

Temperature: 900°F for 3 Hours,
Rapid Cool, 60-64 HRC

PROPERTIES

Density, g/cc.....6.55-6.70
Hardness, Rc
Solution Annealed.....Approx. 53
Aged.....60-64
Transverse Rupture Strength.....200
(psi x 103)
Compressive Strength.....417
(psi x 103)
Impact Strength.....31.5
(Izod unnotched) (in-lbs)
Linear Size Change
Thru Heat Treatment, %.....-0.029

Ferro-Tic Grade HT-6A

GRADE DESCRIPTION

Ferro-Tic Grade HT-6A is an advanced metal matrix composite comprised of ultra-hard titanium carbide grains homogeneously dispersed in a nickel-based binder. In the annealed state, it can be readily machined into any desired shape using conventional tooling. HT-6A exhibits excellent corrosion resistance and toughness. HT-6A is non-magnetic, it is ideal for use in wear parts where this is a requirement.



APPLICATIONS

Ferro-Tic Grade HT-6A is especially suited for tooling that must operate at temperatures up to 1800°F. It is able to withstand severe oxidizing and corrosive environments. HT-6A is widely used as a die insert material for high temperature extrusion tooling.

CHEMICAL COMPOSITION GUIDE (weight %)

Carbide Phase	Binder Phase				
	Cr	Fe	Ti	Al	Ni
Titanium Carbide	18.0	6.0	2.0	1.0	Bal

SOLUTION ANNEALING

Temperature: 2150°F for 1 Hour,
Rapid Cool, 48-52 HRC
(material is supplied in the solution annealed + pre-aged condition)

AGE HARDENING

Temperature: 1400°F for 4 Hours,
Rapid Cool, 59-63 HRC

POPERTIES

Density, g/cc.....6.80
Hardness, Rc
Solution Annealed.....48-52
Pre-Aged.....52-57
Aged.....59-63
Transverse Rupture Strength.....191
(psi x 103)
Compressive Strength.....285
(psi x 103)
Impact Strength.....306
(charpy unnotched) (in-lbs/in²)
Tensile Strength.....153
(psi x 103)
Coefficient of Thermal Expansion x 10⁻⁶ in/in/°F
70°F-900°F.....6.09
70°F-1800°F.....7.38
Linear Size Change
Thru Heat Treatment, %.....-0.014