

## Surface Treatments

	Plating		Nitriding	Boriding	CVD		PVD	TRD		Injection of molten metal	Overlay
	Hard chrome	Nickle 1 Phosphor			Heat CVD	Plasma CVD	Ion plating	Molten salt bath method	Fluidized solid furnace method		
Surface layer	Cr	Ni-P	Fe <sub>2-3</sub> N Fe <sub>4</sub> N	FeB Fe <sub>2</sub> B	TiC,TiN TiCN,W <sub>2</sub> C	TiC,TiN Amorphous carbon	TiN,CrN	VC,NbC Cr-C,VN	VC,TiC Cr-C,TiCN	Ni-Cr-B-Si Ni-Cr-B-Si-WC	Stellite and same as the left.
Procedure	Electrolysis in aqueous solution	Dipping in aqueous solution	①Heating in gas ②Dipping in molten salt ③Discharging in reduced pressure gas	①Heating in powder ②Dipping in molten salt ③Dipping in molten salt ④Heating in gas	Heating in gas	Discharging in reduced pressure gas	In reduced pressure nitrogen gas	①Dipping in molten salt ②Electrolysis in molten salt	Heating in fluidized solid furnace	①Re-melt after spray fluidized solid with gasfire and plasm	Building with molten metal with bars, gasfire of powder and arc.
Temperature of base metal in process (°C)	Surface 50~80	60~100	500~600	600~1000	800~1100 500~600	400~600	400~600	800~1200 (500~650)	800~1100 (500~650)	1000~1100	close to the melting point of the steel
	Center ditto	ditto	①② ditto ③200~500	ditto	ditto	ditto	ditto	ditto	ditto	500~900	300~900
Required time	1~5	1~5	①100~200 ②③1~8	1~4	4~8	1~2	2~4	0.3~8	0.3~8	According to the size of article due to partial coating in small area	
Thickness (μm)	20~50	20~50	10~20 (compound layer)	50~500	3~15	1~5	1~5	3~15	3~15	500~2000	2000~5000
Incidence of strain	low	low	medium	high	high	low	low	high	medium~high	high	high
Local coating	possible	possible	possible	possible	impossible	possible	possible	possible	impossible	possible	possible
Heat curing for hardening base metal	before plating	before plating	before plating	Reheating after treatment or together with the treatment	Reheating after treatment	before plating	before plating	together with the treatment	together with the treatment	Reheating after treatment or together with the treatment	Reheating after treatment or together with the treatment
After-process	Necessity	occasionally required	usually not required	usually not required	usually not required	usually not required	usually not required	usually not required	usually not required	required	required
	Method	Grinding lapping	lapping	lapping	lapping	lapping	lapping	lapping	lapping	lapping	cutting
Thickness uniformity	bad	good	good	good	good	better than PVD, worse than CVD.	bad	good	good	too bad	too bad
Base metal	various steels nonmetal	same as the left	iron and steel	iron, nickel alloy, copper alloy, superalloy and the like	same as the left	same as the left	same as the left	same as the left	same as the left	various steels nonmetal	various metals

Reference : KATA-GIJUTSU(1990.9)

## Relationships between Mold Materials and Heat Treatments

Type	Materials	Heat treatment method	Important points
Surface treatment	Structural alloyed steel	Tufftriding with gas or salt bath (560~580°C)	○Less deformation ○Not suitable to glossy finish
	Carbon tool steel		
	Preharden steel	Ion tufftriding (400~570°C)	○Less deformation ○Glossy finished part should be polished again
	Maraging steel		
Thermal refined alloyed tool steel	Thermal refined 13Cr stainless steels	PVD treatment (400~500°C)	○Less deformation ○Abrasion resistant and release easy ○Glossy surface is coated strong
		CVD treatment (800~1200°C)	○Be careful to deformation ○Abrasion resistant, heat resistant and release easy ○Be careful to deformation
Quenching	Structural alloyed steel	Overall quenching { Gas furnace Electric furnace Salt bath	○Much deformation ○Processing required after quen-ching
	Carbon tool steel		
	Alloyed tool steel	Partial quenching { Frame quenching Laser quenching	○Partial quenching is available
	13Cr stainless steels		
	High-speed steel	Vacuum quenching	○Higher abrasion resistance and pressure resistant strength ○Glossy finish can be maintained. ○Select air-cooling steel
Quenching and surface treatment	Quenching the material with high tempering resistance till very hard	Surface treatment after quenching	○Most abrasion resistant ○Suitable to mass production and engineering plastic

Reference : KATA-GIJUTSU (1989.10)

## 1. General dimensional tolerance of cutting JIS B 0405 — 1991

### Length dimensional tolerance (excluding chamfered parts)

Unit: mm

Degree	Symbol	Explanation	Standard dimension							
			0.5 <sup>(1)</sup> to 3 incl.	Over 3 to 6 incl.	Over 6 to 30 incl.	Over 30 to 120 incl.	Over 120 to 400 incl.	Over 400 to 1000 incl.	Over 1000 to 2000 incl.	Over 2000 to 4000 incl.
			Tolerance							
f	Fine		±0.05	±0.05	±0.1	±0.15	±0.2	±0.3	±0.5	—
m	Medium		±0.1	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2
c	Coarse		±0.2	±0.3	±0.5	±0.8	±1.2	±2	±3	±4
v	Very coarse		—	±0.5	±1	±1.5	±2.5	±4	±6	±8

Note<sup>(1)</sup> : Tolerance for standard dimensions of less than 0.5mm shall be specified individually.

## 2. Length dimensional tolerance in chamfered parts

### (corner roundness or chamfer dimension)

Unit: mm

Degree	Symbol	Explanation	Standard dimension		
			0.5 <sup>(1)</sup> to 3 incl.	Over 3 to 6 incl.	Over 6
			Tolerance		
f	Fine		±0.2	±0.5	±1
m	Medium		±0.2	±0.5	±1
c	Coarse		±0.4	±1	±2
v	Very coarse		±0.4	±1	±2

Note<sup>(1)</sup> : Tolerance for standard dimensions of less than 0.5mm shall be specified individually.

## 3. Tolerance of angle dimension

Unit: mm

Degree	Symbol	Explanation	Shorter side of corner				
			10 or less	Over 10 to 50 incl.	Over 50 to 120 incl.	Over 120 to 400 incl.	Over 400
			Tolerance				
f	Fine		±1°	±30'	±20'	±10'	±5'
m	Medium		±1°	±30'	±20'	±10'	±5'
c	Coarse		±1° 30'	±1°	±30'	±15'	±10'
v	Very coarse		±3°	±2°	±1°	±30'	±20'

Note<sup>(1)</sup> : Tolerance for standard dimensions of less than 0.5mm shall be specified individually.

## 4. General tolerance of perpendicularity

JIS B 0419 — 1991

Unit: mm

Degree	Nominal length on shorter side			
	100 or less	Over 100 to 300 incl.	Over 300 to 1000 incl.	Over 1000 to 3000 incl.
	Squareness tolerance			
H	0.2	0.3	0.4	0.5
K	0.4	0.6	0.8	1
L	0.6	1	1.5	2

## 5. General tolerance of straightness and flatness

JIS B 0419 — 1991

Unit: mm

Degree	Nominal area					
	10 or less	Over 10 to 30 incl.	Over 30 to 100 incl.	Over 100 to 300 incl.	Over 300 to 1000 incl.	Over 1000 to 3000 incl.
	Straightness and flatness tolerance					
H	0.02	0.05	0.1	0.2	0.3	0.4
K	0.05	0.1	0.2	0.4	0.6	0.8
L	0.1	0.2	0.4	0.8	1.2	1.6