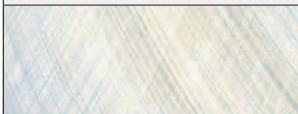
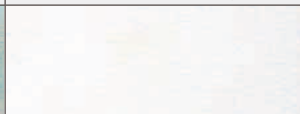


Types & Apparent Colors of Surface Treatment

Types of Surface Treatment

Name		Vickers Hardness (HV)	Layer Thickness (μm)	Applicable Materials	Example	Purpose, Features	Reference
Zinc Plating		—	3~20	Steel	Thin Plate Wire	– Antirust, low price – Poor appearance	—
Chromate Plating		—	1~2	Steel	Plate Work Bolts and Nuts	– Antirust, low price – Fit for mass production – Poor appearance, however, works instead of nickel plating	—
Bright Chromate		—	1~2	Steel	—		
Trivalent Chromate		—	1~2	Steel	Bolts and Nuts	– Antirust, low price – Do not contain hexavalent chrome	—
Nickel Plating		—	—	Steel Copper Brass	—	– Improvement of corrosion resistance and decoration – Chrome plating has more corrosion resistance in the atmosphere.	– Copper base plating as appropriate – Not applicable to deep indentations
Class 1 Plating		500	5~20			– Better appearance than Class 3 plating	Material...Buff...UPlating...Buff
Class 3 Plating						–	Material...Plating
Satin Finish Plating		—	—			– Fatigue resistance – Minor flaws remain inconspicuous	Material...Satin finish...Plating
Electroless Nickel Plating		500	Specifiable	Steel Stainless Steel Copper	Parts Unsuitable for Nickel Plating	– Approx.10 times more expensive than nickel plating – Easy film thickness control – High corrosion resistance, abrasion resistance – Give Conductivity to Non-Metals	—
Kanigen Plating		Up to 1000		Aluminum Alloy Glass Plastic	Parts hardened after Plating	– Same as the features of electroless nickel plating – Can be hardened by heat treatment after plating	
Chrome Plating		—	—	Steel Copper Brass	—	– Appearance with gloss – Good corrosion resistance – Sliding chrome plating surfaces are easy to stick together	–Nickel base plating as appropriate. – Not applicable to deep indentations.
Class 1 Plating		500	5~20			– Better appearance than Class 3 plating	Material...Buff...UPlating...Buff
Class 3 Plating						—	Material...Plating
Satin Finish Plating		—	—			– Fatigue resistance – Minor flaws remain inconspicuous	Material...Satin finish...Plating
Hard Chrome Plating		1000	10~30		Cylinder Liners	– Excellent abrasion resistance – More expensive than other chrome plating	Material...Plating (Class 3 Plating)
Black Oxide (Blackening)		—	—	Steel	Bolts Nuts Instruments	– Base coating – Appearance (with gloss) – Rusts more easily than Tuffride	General Black Oxide
Low-Temperature Black Chrome Plating		—	1~2	Steel Copper Stainless Steel	Items requiring high precision, items requiring higher corrosion resistance than blackening.	– Long term antirust performance – High corrosion resistance – Ultra thin film	Low-Temperature Preliminary Treatment. No thermal effect on raw material. Parts coupled with plastic matter, rubber, etc.
Anodize	Clear	—	3~5	Aluminum Alloy	—	– Corrosion and abrasion resistance – No electric conductivity – Heat Resistance	Some anodize pieces are colored through fine holes in the hard, oxidized film formed on the surface.
	Black	—	5~10				

Apparent Colors of Surface Treatment

Bright Chromate	Trivalent Chromate	Electroless Nickel Plating	Hard Chrome Plating
			
Black Oxide	Anodize(Clear)	Anodize(Black)	
			

Hardening & Hardness Test Methods

Heat Treatment for Steel Materials

Name	Vickers Hardness (HV)	Hardening Depth (mm)	Strain	Applicable Materials	Typical Material	Reference
Through Hardening	750 or Less	Full Depth	Varies according to materials	High Carbon Steel C>0.45%	01 Tool Steel JIS-SKS21 52100 Bearing Steel M2 Tool Steel JIS-SKS93 W1-9 Tool Steel 1045 Carbon Steel	<ul style="list-style-type: none"> Operation of heating copper to an appropriate temperature over transformation point and quickly cooling it in an appropriate medium in order to increase hardness or improve strength. Not applicable to long or precision parts, such as spindles, etc.
Carburization	500 or Less	Standard 0.5 Up to 2	Moderate	Low Carbon Steel C<0.3%	SCM415 Alloy Steel JIS-SNCM220	<ul style="list-style-type: none"> Applicable to partial hardening Hardening depth should be specified on drawings Applicable to precision parts
Induction Hardening	750 or Less	1~2	High	Medium Carbon Steel C 0.3~0.5%	1045 Carbon Steel	<ul style="list-style-type: none"> A surface hardening method that uses high frequency induction current to quickly heat and cool the steel surface Applicable to partial hardening Expensive in small-volume lots High fatigue resistance
Nitriding	900~1000	0.1~0.2	Low	Nitriding Steel	JIS-SCM645	<ul style="list-style-type: none"> A surface hardening method that forms hardening layer of hard nitride compounds on the steel surface Obtains highest degree of hardness among all hardening techniques Fit for mass production Applicable to spindles for sliding bearing
TUFFTRIDE is the trademark of Duferrit GmbH, Germany (salt bath process)	Carbon Steel 500 Stainless Steel 1000	0.01~0.02	Low	Steel Material	1045 Carbon Steel SCM415 Alloy Steel W1-10 Tool Steel Stainless Steel	<ul style="list-style-type: none"> Tufftride is one of the nitriding methods called soft-nitriding (salt bath process) High fatigue resistance and abrasion resistance Same corrosion resistance as zinc plating Not applicable to precision parts because of incapability of polishing after heat treatment Applicable to oil free bearings.
Bluing	—	—	—	Wire Rod	JIS-SWP-B	<ul style="list-style-type: none"> Low temperature annealing Removes internal stress during forming to enhance elasticity

Hardness Test Methods & Applicable Parts

Testing Method	Principle	Applicable Heat-Treated Parts	Features	Reference
Brinell Hardness	<ul style="list-style-type: none"> A (steel or super hard alloy) ball indenter is used to indent the test surface. Hardness is given as a quotient divided by the surface area of the dent, computed from the diameter. 	<ul style="list-style-type: none"> Annealing Normalized parts Anchored materials 	<ul style="list-style-type: none"> Applicable to uneven materials and forged products because indent is large Not applicable to small or thin specimens 	JIS Z2243
Rockwell Hardness	<ul style="list-style-type: none"> This standard or test load is applied via a diamond or ball indenter. Hardness is read on a tester. 	<ul style="list-style-type: none"> Hardening tempered parts Carburized surfaces Nitrided parts Thin sheets such as copper, brass, bronze, etc. 	<ul style="list-style-type: none"> Hardness value obtained quickly Applicable to intermediate testing of actual products Caution is required as there are 30 types 	JIS Z2245
Shore Hardness	<ul style="list-style-type: none"> The specimen is set on a table. A hammer is dropped from a uniform height. Hardness is based on how height the hammer bounces. 	<ul style="list-style-type: none"> Hardening tempered parts Nitrided parts Large carburized parts, etc. 	<ul style="list-style-type: none"> Extremely easy to operate and data can be obtained quickly Applicable to large parts Indent is kept shallow, therefore is applicable to actual products Portable, as being compact and light weight 	JIS Z2246
Vickers Hardness	<ul style="list-style-type: none"> Uses a diamond 136°square pyramid indenter. Hardness value is obtained from the surface area of the dent, computed from the experimental load and the length of the diagonal lines of the dent. (Automatically calculated) 	<ul style="list-style-type: none"> This hardening layers by induction hardening, carburizing, nitriding, electrolytic plating, ceramic coating, etc. Hardening layer depth in carburized and nitrided parts 	<ul style="list-style-type: none"> Applicable to small and thin specimens Applicable to all materials because of diamond indenter 	JIS Z2244