Standard pieces of iron, steel and non ferrous alloy microstructures.

Standard Microstructure

together with photos and detailed explanations.

Originated in the Tokyo Metroporitan Industrial Technology Center Under the Leadership of Emeritus Prof. Takejiro Murakami, D.Sc.

with CD-ROM

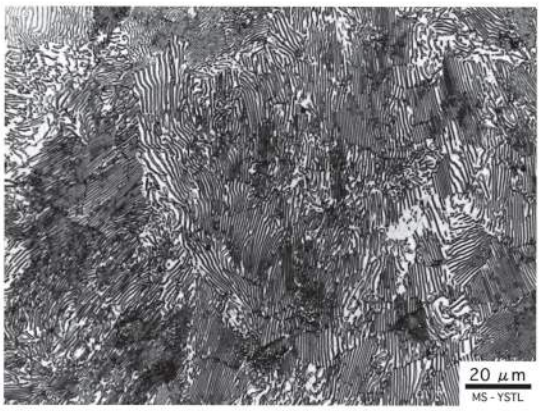
- Group 1. Ferrous-Carbon steel, Cast iron, Cast steel
- Group 2. Alloy tool steel, High speed steel
- Group 3. Structural alloy steel, Steel for special use
- Group 4. Non Ferrous Alloy
- Group 6. Surface Modification of Metals
- Group 7. Abnormal Micro-structures

The standard for the microstructures of the selected steels and non ferrous alloys were prepared by the Tokyo Metropolitan Industrial Technology Center under precise heat treatment conditions.

The set of standard microstructures provided with a detailed manual with photographs and metalographical explanations for each micro-structures.

YAMAMOTO Scientific Tool Laboratory Co., Ltd.
Chiba, Japan

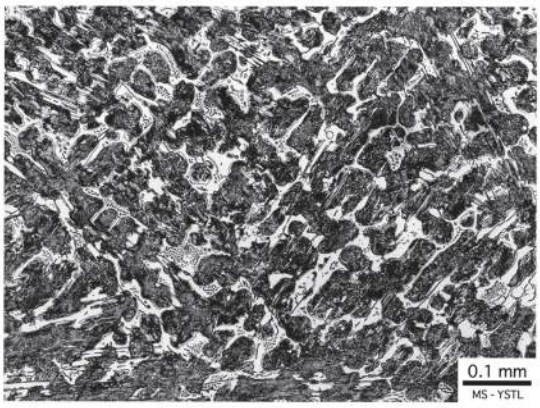
Example of Standard Microstructure



Standard piece No.3 pearlite

Pearlite

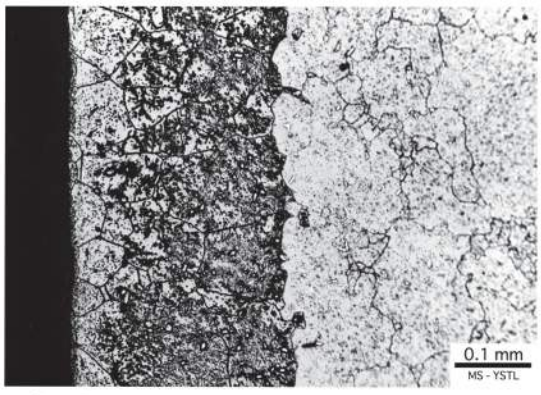
Structure: Lamellar structure of ferrite and cementite. White layers are cementite and somewhat of them appears a setup in relief.
Magnification: ×400
Etching reagent: 3% nital (keep 6~9sec)
Composition: C 0.86%, Si 0.17%, Mn 0.22%, P 0.011%, S 0.004%
Heat treatment: 950°C annealing
Hardness: HB 180-200



Standard piece No.20 White pig Iron

White Pig Iron

Structure: White parts are cementite. Black parts are pearlite transformed from austenite. Honeycomb parts are eutectic structures of austenite and cementite called Ledeburite.
Magnification: ×120
Etching reagent: 3% nital (keep 7~8sec)
Composition: C 2.95%, Si 0.80%, Mn 0.36%, P 0.036%, S 0.150%
Treatment: As Cast
Hardness: White pig iron of chilled roll : HS 60～75
Cr alloyed white pig iron : HS 90

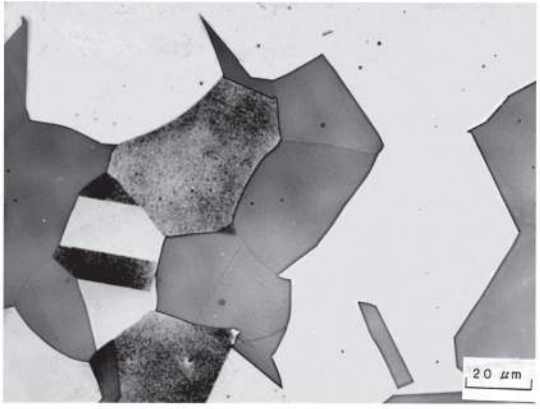


Standard piece No.54 Decaburized structure

Decaburized Structure

(High Speed Steel)

Structure: The part on left side is Decarburized structure.
Black part on the decarburized structure is Troostite.
Network parts show Double carbide.
The part on the right side is Quenching Martensite.
Magnification: (including the retained Austenite)
Etching reagent: ×400
Composition: 50% $FeCl_3$
C 0.88%, Si 0.32%, Mn 0.30%, P 0.018%, S 0.004%
Cr 3.99%, Mo 4.92%, W 6.18%, V 1.86%
Heat Treatment: 1240°C × 20min(oxidizing atmosphere), Oil quenching



Standard piece No.83 High manganese steel

High manganese Steel

(Water-Toughened Structure)

Structure: austenite.
Magnification: ×400
Composition: C 1.07%, Si 0.24%, Mn 12.34%, P 0.023%, S 0.007%, Cr 0.17%, Cu 0.14%
Heat Treatment: 1000°C × 20min, Water quenching
Mechanical properties: Tensile strength : 75kg/mm²
Hardness : about HB 210

Group 1 **Ferrous-Carbon Steel • Cast Iron** 25 Types

At the beginning of the world, humankind discovered soft iron, and using its malleability they made farming implements and everyday tools. Later, they found that by increasing its carbon content they could strengthen it.

Eventually they developed the technics for manufacturing steel. Furthermore, they found that it showed great hardness (at the stage of Martensite), to a degree that had no equal in the world, when treated by quenching. As a result, they made remarkably sharp tools and blades.

Then, by increasing the carbon content of iron, they found they could use it for anything, such as the structures of all kinds of machines, and by directly pouring melted steel into a mold they succeeded in the manufacture of cast steel.

We have great admiration for the efforts and abilities of our predecessors.

Standard Piece Number	JIS mark	Main component (%)	Heat treatment operation mark	The details of Heat treatment	Microstructure
Standard condition of the structure					
1	Armco Iron	C 0.02	HNR	950℃ HNR	Ferrite
2	S45 C	C 0.45	HNR	930℃ HNR	Pearlite + Ferrite
3	SK 85	C 0.8	HA	930℃ (Fc)	Pearlite
4	SK 120	C 1.2	HA	950℃ (Fc)	Network Cementite
5	SK 120	C 1.2	HA	760℃ (Sc) 720℃ (Fc)	Spheroidized Cementite
Quenching, Tempering Structure					
6	SK 85	C 0.8	HQ	850℃ HQ(W)	Martensite
7	SK 85	C 0.8	HQ, HT	850℃ (W), 350℃ HT	Troostite (Tempering)
8	SK 85	C 0.8	HQ, HT	840℃ HQ(W), 580℃ HT	Sorbite (Tempering)
Isothermal Quenching Structure					
9	SK 85	C 0.8	HQA	930℃→400℃×50s Salt bath Isothermal Quenching	Upper Bainite
10	SK 85	C 0.8	HQA	885℃→295℃×15min Salt bath Isothermal Quenching, Water cooling	Lower Bainite
Quenching Structure					
11	SK 120	C 1.2	HQ	110℃ HQ(O)	Martensite and Retained Austenite
12	SK 120	C 1.2	HQ	800℃ HQ(W), 100℃ HT	Martensite and Spheroidized Cementite
13	S 45 C	C 0.45	HQ	850℃ HQ(W)	Martensite and Fine Pearite
14	S 30 C	C 0.3	HQ	930℃ (Ac)→720℃ HQ(W)	Martensite and Ferrite
Induction Hardened Structure					
15	S 45 C	C 0.45	HQI	Heat up to 870℃ on the surface by Induction heating, Spray hardening	Fine Martensite
Carburized, Decarburized, and Gas Nitrocarburized Structure					
16	S 15 CK	C 0.15	HC	900℃×3h Carb, (Sc)	Carburized Structure
17	S 45 C	C 0.45	HNTS	880℃×1h 580℃×1.5h HT 570℃×3.5h HNTS	Gas Nitrocarburizing
18	SK 85	C 0.8	(Dec)	900℃×6h in Al_2O_3 (Fc)	Decarburized Structure
Overheated Structure					
19	S 30 C	C 0.3	(OH)	1240℃×40min, (Ac)	Widmanstatten structure
Cast Iron Structure					
20	White pig Iron	C 2.95	Si 0.80	As cast	Ledeburite and Pearlite
21	Gray Cast Iron	C 3.43	Si 2.06	As cast	Flake graphite and Pearlite
22	Spheroidal Graphite Cast Iron	C 3.45	Si 2.81	As cast	Spheroidal Graphite and Pearlite
23	Eutectic Graphite Cast Iron	C 3.78	Si 2.09	As cast	Eutectic Graphite and Pearlite
24	Black Heart Malleable Cast Iron	C 2.67	Si 1.07	Malleablizing	Temper Carbon and Ferrite
Cast Steel Structure					
25	Cast Steel	C 0.22	Si 0.30	900℃×1h (Ac)	Pearlite and Ferrite

Outline of operation mark

HA: Annealing	(Dec): Decarburization	(Ac): Air cooling	HT: Tempering
HNR: Normalizing	HQ(O): Oil quenching	(Sc): Slow cooling	HQI: Induction hardning
HQA: Austemper	HC: Carburizing	(OH): Over heating	HQ(W): Water quenching
HQ: Quenching	HNTS: Nitriding	(Fc): Furance cooling	(Sz): Sub-Zero

Group 2 **Alloy Tool Steel • High Speed Steel** 25 Types

In order to make all the kinds of tools which we need firs.t, having added ferrous-carbon steel to chrome, we intensively carbonized it, and further, by adding tungsten at the same time, we manufactured double carbide which has remarkable machining properties as well as durability,

Then, we manufactured impact resisting tools, wear resistant non-deformation tools, and hot working steels.

High speed steels, for tool blades which are not corroded by heating during cutting. And do not wear especially high speed steels that contain cobalt, keep their hardness tough in high temperatures and consequently result in durable cutting tools.

High speed steels have made remarkable progress.

In addition, the powder high speed steels, with a carbonized microstructure has realized advanced mechanical features.

Standard Piece Number	Main use	JIS mark	Main component (%)	Heat treatment operation mark	The details of Heat treatment	Microstructure
Alloy tool steel 14 pcs.						
33	For Cutting	SKS 2	C 1.04 Cr 0.64 W 1.01	HA	820℃×40min→780℃×70min →(Sc)(20℃/h)→580℃→(Fc)	Annealed Structure
34				HQ, HT	860℃×30min HQ(O), 180℃×60min HT	Hardened, Tempered Structure
35	For Wear resistance & non-deformation	SKS 3	C 0.97 Mn 1.01 Cr 0.88 W 0.75	HA	740℃×30min→(Sc)(15℃/h)→550℃→(Fc)	Annealed Structure
36				HQ, HT	840℃×30min 180℃×60min HT	Hardened, Tempered Structure
37	For anti-Impact	SKS 4	C 0.52 Cr 0.89 W 0.85	HQ, HT	875℃×30min HQ(O), 180℃×60min HT	Hardened, Tempered Structure
38	For Wear resistance & non-deformation	SKD 11	C 1.47 Cr 11.96 Mo 0.83 V 0.25	HA	850℃×3h→(Sc)(20℃/h)→580℃→(Ac)	Annealed Structure
39				HQ	1030℃×30min HQ(O)	Hardened Structure
40				HQ, HT(L)	1030℃×30min HQ(O), 180℃×60min HT	Hardened, Tempered Structure (Low)
41				HQ, HT(H)	1030℃×30min HQ(O), 520℃×60min HT	〃 (High)
42	For Hot working	SKD 61	C 0.39 Si 0.93 Cr 5.15 Mo 1.24 V 0.59	HA	830℃×3h→(Sc)(20℃/h)→600℃→(Ac)	Annealed Structure
43				HQ	1030℃×30min HQ(O)	Hardened Structure
44				HQ, HT	1030℃×30min HQ(O), 560℃×60min HT	Hardened, Tempered Structure
45		SKD 4	C 0.34 Cr 2.59 W 5.36 V 0.35	HQ, HT	1030℃×30min HQ(O), 650℃×90min HT	Hardened, Tempered Structure
46		SKT 4	C 0.50 Ni 1.67 Cr 1.23 Mo 0.32 V 0.14	HQ, HT	850℃×30min HQ(O), 650℃×60min HT	Hardened, Tempered Structure
High Speed Steel 11 pcs.						
47	For Heavy cutting	SKH 2 W system	C 0.83 Cr 4.00 W 17.13 V 0.86	HA	850℃×3h→(Sc)(20℃/h)→600℃→(Ac)	Annealed Structure
48				HQ, HT×3	1260℃×90sec HQ(O) 560℃×60min HT×3	Hardened, Tempered Structure
49		SKH 4 Co system	C 0.82 Cr 4.04 W 17.27 V 1.11 Co 9.14	HQ	1300℃×90sec HQ(O)	Hardened Structure
50				HQ, HT×3	1300℃×90sec HQ(O), 570℃×60min HT×3	Hardened, Tempered Structure
51		SKH 51 Mo system	C 0.88 Cr 3.99 Mo 4.92 W 6.18 V 1.86	HA	850℃×3h→(Sc)(20℃/h)→600℃→(Ac)	Annealed Structure
52				HQ	1220℃×90sec HQ(O)	Hardened Structure
53				HQ, HT×3 (Dec)	1220℃×90sec HQ(O), 550℃×60min HT×3	Hardened, Tempered Structure
54					1240℃×20min HQ(O)	Decarburized Structure
55		SKH 55 Mo system	C 0.88 Cr 3.94 Mo 4.96 W 6.04 V 1.81 Co 4.70	HQ, HT×3	1240℃×90min HQ(O), 570℃×30min HT×3	Hardened, Tempered Structure
56	P/M High Speed Steel	HAP40 (Equivalent to SKH 57)	C 1.28 Cr 4.23 Mo 4.99 W 6.49 V 3.06 Co 8.00	HQ	1200℃×90sec HQ(O)	Hardened Structure
57				HQ, HT×3	1200℃×90sec HQ(O), 560℃×30min HT×3	Hardened, Tempered Structure

Group 3 Structural Alloy Steel • Steel for Special uses 25 Types

As for structural alloy steel, we give two examples of high tensile steel that contain some special elements, mainly Si, Mn, which produce a light-weight highly tensile steel.

In addition, high tensile steel is easy to weld and minimizes the hardness of the weld and its brittleness when notched.

We also show two kinds of high tensile structural steel, case hardening steel, and nitriding steel in this booklet.

As to steels for special applications, we gave as example a free cutting steel, bearing steel, high manganese steel, six kinds of stainless steel, two kinds of heat reslstlng steel, spring steel, and at last, permanent magnet steel, Alnico V and silicon steel.

Permanent magnet steels have usually varied depending on the forging methods used, but they have been manufactured in various forms as well as on a large scale by casting methods and have been used in factories throughout the world.

Standard Piece Number	Kind of steel	JIS mark	Main component (%)	Heat treatment operation mark	Details of Heat treatment	Microstructure
Structural alloy steel 9 pcs.						
61	High tensile strength steel	SM 50	C 0.10 Si 0.24 Mn 0.75	As rolling		As Rolled
62		(80kg) class	C 0.10 Si 0.24 Mn 0.75	HQ, HT	910℃ HQ, 640℃ (Ac)	Thermal Refining Structure
63	Machine structural alloy steel	SNCM 439	C 0.39 Ni 1.68 Cr 0.77 Mo 0.17	HA	850℃×2h→630℃ (15℃/h), 630℃×2h (Fc)	Annealed Structure
64				HQ, HT	850℃×30min HQ(O)→630℃×60min HT	Thermal Refining Structure
65		SCM 435	C 0.37 Cr 1.13 Mo 0.15	HA	850℃×2h→650℃ (15℃/h), 650℃×2h (Fc)	Annealed Structure
66				HQ, HT	850℃×30min HQ(O), 600℃×60min HT	Thermal Refining Structure
67		SCM 415	C 0.15 Cr 1.14 Mo 0.18	HC	930℃×2h (Carb), 930℃ 1h diffused→(Fc)	Carburized Structure
68				HQ, HT	930℃×2h (Carb), 930℃×2h diffused, 880℃ HQ(O) 180℃×2h HT	Carburized Hardened and Tempered Structure
69		SACM 645	C 0.48 Cr 1.43 Al 0.89 Mo 0.17	HNTS	930℃×30min HQ(O), 700℃×60min HT 500℃×50h HNTS	Nitrided Structure
Steel for Special use 14 pcs.						
70	Free cutting steel	SUM 23	C 0.06 Mn 0.85 S 0.275	HNR	900℃×20min (Ac)	Normalized Structure
71	Bearing steel	SUJ 2	C 0.98 Mn 0.32 Cr 1.33	HA	920℃×40min (Ac), 780℃×70min→580℃ (Fc) (10℃/h)	Spheroidized Structure
72				HQ, HT	850℃×30min HQ(O), 180℃×60min HT	Hardened, Tempered Structure
73	Stainless steel	SUS 403	C 0.13 Cr 11.87	HQ, HT	1000℃×30min HQ(O), 700℃×60min HT	Thermal Refined Structure
74		SUS 420 J2	C 0.38 Cr 13.52	HQ, HT	950℃×30min HQ(O), 200℃×60min HT	Thermal Refining Structure
75		SUS 430	C 0.09 Cr 16.69	HA	750℃×30min (Ac)	Annealed Structure
76		SUS 304	C 0.06 Cr 18.50 Ni 9.52	HQ	1100℃×30min HQ(W)	Solution Treated Structure
77		SUS 321	C 0.04 Cr 17.05 Ni 9.23 Ti 0.32	HQ	930℃×60min HQ(W)	Stabilized Structure
78		SUS 316	C 0.06 Cr 17.57 Ni 12.34 Mo 2.40	HQ, HT	1100℃×30min HQ(O), 700℃×60min HT	Hardened, Tempered Structure
79		SUS 631 (17-7PH)	C 0.05 Cr 16.49 Ni 7.38 Al 0.94	HQ, HT	Pre-treatment (1030℃ Water cooling solid solution treatment), 950℃×10min Ac, -78℃ 8h Sz, 510℃×60min HT	Precpition Hardning Structure
80	Heat resisting steel	SUH 31	C 0.39 Cr 14.15 Ni 14.50 W 2.40 Si 1.71	HQ	980℃×45min HQ(O)	Solution Treated Structure
81		SUH 310	C 0.15 Cr 24.55 Si 0.57 Ni 19.40	HQ	1050℃×30min HQ(W)	Solution Treated Structure
82	Spring steel	SUR 6	C 0.59 Si 1.63 Mn 0.86	HQ, HT	860℃×30min HQ(O), 500℃×90min HT	Thermal Refined Structure
83	High manganese steel	SC Mn H2	C 1.07 Mn 12.34	HQ	1000℃×20min HQ(W)	Water-Toughened Structure
Electron magnet materials 2 pcs.						
84	for Permanent magnet	Alnico	Al 7.8 Ni 15.3 Co 25.1 Cu 3.3		After Casting, 1260℃ solid solution treatment, 600℃ Aging	Cas, Aged Structure
85	Silicon steel		Si 3.02	HA	800℃×3h Vacum annealing	Annealed Structure

Standard Microstructure Group 4 Non-ferrous Alloy

25types

Due to remarkable advances in nonferrous metallic materials, such as copper alloys, aluminum alloys, titanium alloys and superalloys, the MS Committee, the Study Group of Material Technology Education, has thoroughly reviewed the standard microscopic structures of these nonferrous metallic materials based on careful examinations. This renewed set of Standard Microscopic Structure Samples, as with its former versions, provides a good understanding of the quality, heat treatment conditions and microscopic structure of material by offering their standard pieces and explanatory documents thereon, along with detailed explanations on a CD-ROM.

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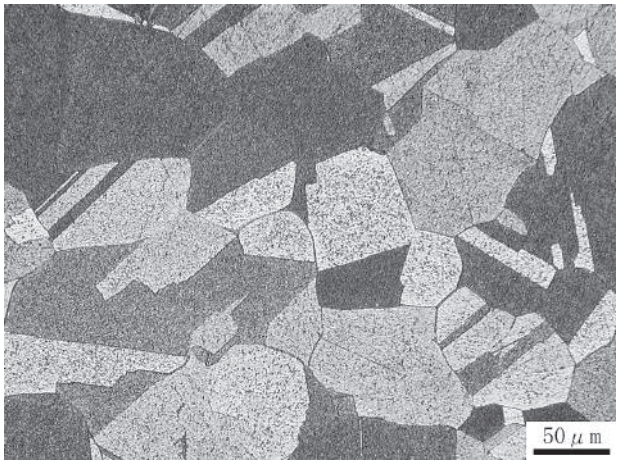
Standard Piece Number	The Property of Material	JIS Mark		Micro Structure
		Number of Standard	Mark of Alloy	
Copper and its alloy 8 pcs.				
101	Oxygen Free Copper	H3100B(P,R):H3250(B)	C1020	Annealed Structure
102	High Strength Wear Resistant Brass	H5120	CAC303(+Si, Ni)	Hot Extruded Structure
103	Aluminum Bronze	H3250	C6191	Hot Extruded Structure
104	Phosphor Bronze	H3270	C5212	Annealed Structure
105	Cupro Nickel	H3100	C7150	Annealed Structure
106	Nickel Silver	H3110(P,R):H3270(B,W)	C7541	Annealed Structure
107	Nicke Silicon Copper Alloy	Z3234	Ni 2 Si	Age Hardened Structure
108	Copper Chromium Alloy	Z3234	Type 2	Age Hardened Structure
Aluminium and its alloy 10 pcs.				
109	Wrought Aluminum	H4000	A1100	Annealed Structure
110	Al-Mn-Mg Alloy	H4000	A3004	Annealed Structure
111	Al-Mg Aluminum alloy	H4000	A5052	Annealed Structure
112	Al-Mg-Si Aluminum Alloy	H4000	A6063	Annealed Structure
113	Al-Zn-Mg-Cu Alloy (Extra Super Duralumin)	H4000	A7075	Annealed Structure
114	Aluminum Alloy Castings AC2B(Lautal Ai－Si－Cu Alloy)	H5202	AC2B	As Cast Structure
115	Aluminum Alloy Castings AC4H (Ai－Si－Mg Alloy)	H5202	AC4CH	Age Hardened Structure
116	Aluminum Alloy Castings AC8A (Lo-Ex: Low Expansion Al-Si-Cu-Mg-Ni Alloy)	H5202	AC8A	Age Hardened Structure
117	Aluminum Alloy Die Castings ADC 12 (Ai-Si-Cu Alloy)	H5302	ADC12	As Cast Structure
118	Aluminum Alloy Die Castings ADC 14 (Hyper Silmuin Ai-Si-Cu-Mg Alloy)	H5302	ADC14	As Cast Structure
The other metal and its alloy except Copper, Aluminium 7 pcs.				
119	Commercially Pure Titanium	H4600	TP340H	Annealed Structure
120	α Titanium Alloy (Ti－5Al－2.5Sn Alloy)	(ASTM Grade6)＊＊		Annealed Structure
121	α－β Titanium Alloy (Ti－6Al－4V Alloy)	(ASTM Grade5)＊＊		Annealed Structure
122	β Titanium Alloy (Ti－15V－3Cr－3Sn－3Al Alloy)	(ASTM 4914)＊＊		Annealed Structure
123	Titanium－Nickel Shape Memory Alloy	H7107		shape memorial structure
124	Nickel Base Superalloy : Alloy 713C	(ASTM 5391B)＊＊＊		As Cast Structure
125	Nickel－Base Superalloy : Hastelloy X	H4551	NW6002(NiCr21Fe18Mo9)	Annealed Structure
Appendix (Only the explanation)				
Appendix1	Zinc Alloy for Die Castings	H5301	ZDC2	As Cast Structure After Die Casting
Appendix2	White Metal	H5401	WJ2	As Cast Structure
Appendix3	Magnesium Alloy Die Castings MDC1D (Mg-Al-Zn Alloy)	H5303	MDC1D	As Cast Structure

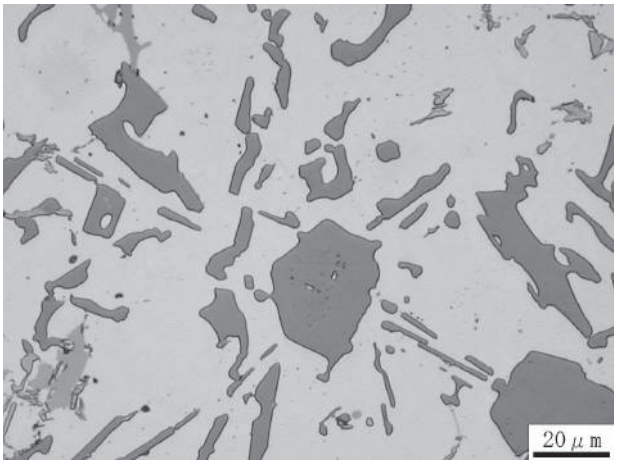
Note ※ Mark shows its sharp, B ; bar, P ; plate R ; ribbon W ; wire ＊Parentheses is Standard Numbers other than JIS
＊＊ ASTM American Society for Testing and Materials ＊＊＊ASM : USA's Aerospace Materials

No.101 Oxygen Free Copper



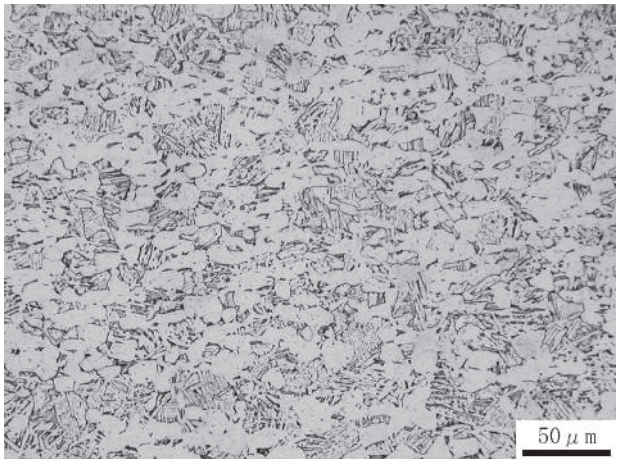
Homogeneous polygonal grains.The crystal grain boundaries are linear because they do not contain inclusions.

No.116 Aluminum Alloy AC8A (Lo-Ex: Low Expansion Al-Si-Cu-Mg-Ni Alloy)



The white base represents a primary α-Al phase. The grayish white, flat, plate crystals represent a eutectic Si phase. The black phase represents a compound phase of Al3Ni and Y (Al-Cu-Ni).

No.121 α－β Titanium Alloy (Ti－6Al－4V Alloy)



A standard annealed structure, where two phases—the white proeutectoid α-phase (equiaxial crystals) and the black retained β phase—coexist.

Standard Microstructure　Group 6　Surface Modification of Metals

25types

- Recently, there have been remarkable advances in surface modification and surface heat-treatment technologies for metallic materials. A variety of such technologies are becoming increasingly available to achieve metallic materials with desired qualities by modifying a material's surface or its adjacent properties. This trend presents unprecedented challenges to the people involved in the materials industry.

- Under the guidance of the MS Committee, the Study Group of Material Technology Education, YSTL has developed "Standard Microstructure Group 6," a set of standard microstructure samples of metallic materials subject to 25 major surface modification or heat treatment technologies, as described below.

- Group 6 addresses the 25 most popular combinations of materials and surface treatment technologies. Following deliberations of the MS Committee, it was determined what the most representative microstructures of the materials should look like when they are surface treated, and YSTL produced standard samples of those microstructures. The attached booklet provides detailed descriptions of material, treatment and microstructure, aided by a photograph of each sample's microstructure and an explanatory CD-ROM, to ensure a better understanding of the samples.

- Combined use with the previously released Group 1 to Group 7 sets of standard microstructure samples is recommended.

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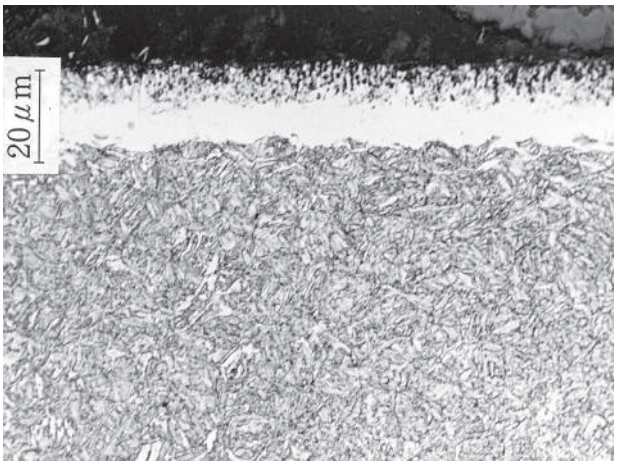
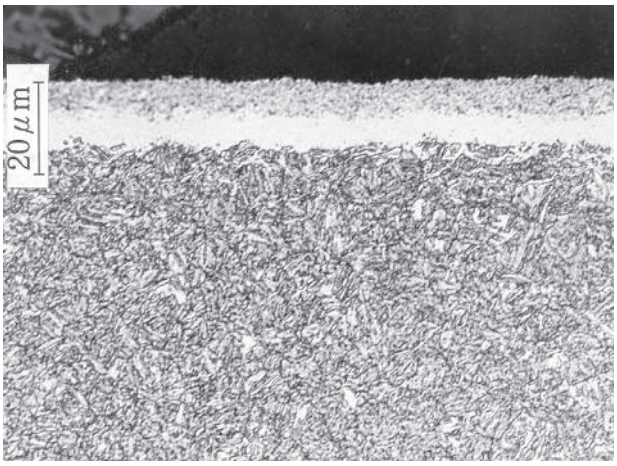
No.	Surface Modification Technology	Material (JIS)	Intended Quality		
			Abrasion resistance	Fatigue resistance	Corrosion resistance
601	Induction Hardening	SCM435	△	○	
602	Flame Hardening	FCD700	○	△	
603	Laser Hardening	SCM435	○		
604	Vacuum Carburizing	SCM415	○	○	
605	Carbide Dispersion Curburizing	MAC14 (Mitsubishi Steel)	○	○	
606	Plasma Nitriding (Ⅰ)	S45C	○	○	△
607	Plasma Nitriding (Ⅱ)	SCM435	○	○	△
608	Liquid Nitriding	S45C	○	○	△
609	Oxinitriding	S45C	○	△	△
610	Gas Nitroc-curburizing	SPCC	○	○	△
611	Sulpho-Nitriding (Low sulphur)	SCM435	○	△	
612	Sulpho-Nitriding (High sulphur)	SCM435	○	△	
613	Boronizing (Boriding)	S35C	○	△	
614	Steam Treatment	S45C	○		△
615	Low-Temperature Sulphurizing	SCM415	○	○	
616	Carbide Coating (TD treatment)	SKD11	○		
617	Thermal CVD (chemical vapor deposition)	SKD11	○		○
618	Plasma CVD	SKD11	○		○
619	PVD (physical vapor deposition)	SKD11	○		○
620	Aluminum Diffusion Coating (alminizing)	S10C	△		○
621	Chromium Diffusion Coating	S10C	○		○
622	Hardness Chromium Plating	SWY11	○		
623	Electroless Nickel Plating	SWY11	○		
624	Spraying	S10C	○		○
625	Aluminum Anodization	A5052 (Al-Mg alloy)	○		○

The ○ and △ marks represent the intended quality.

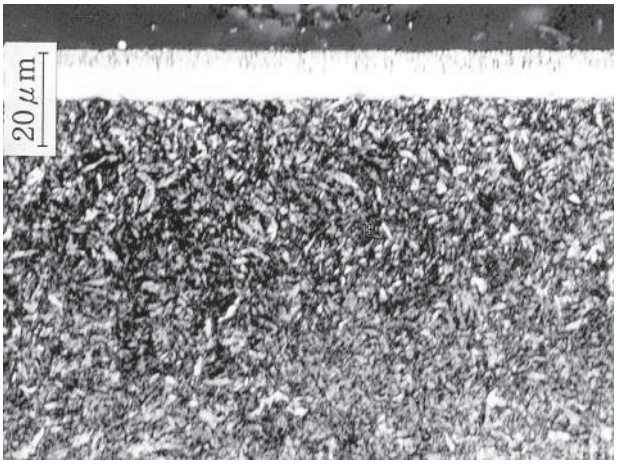
No.608 Liquid Nitriding (S45C)



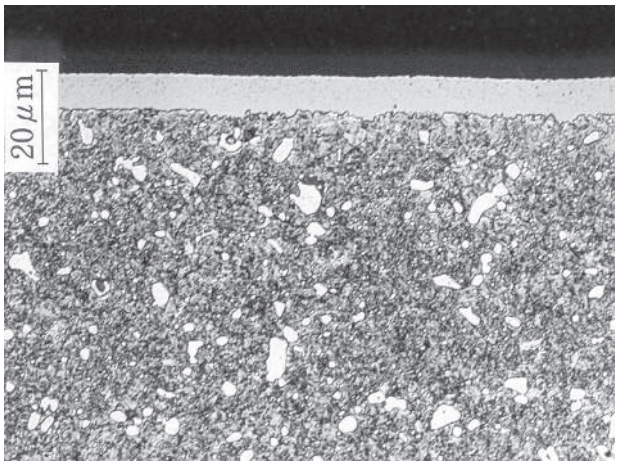
No.609 Oxinitriding (S45C)



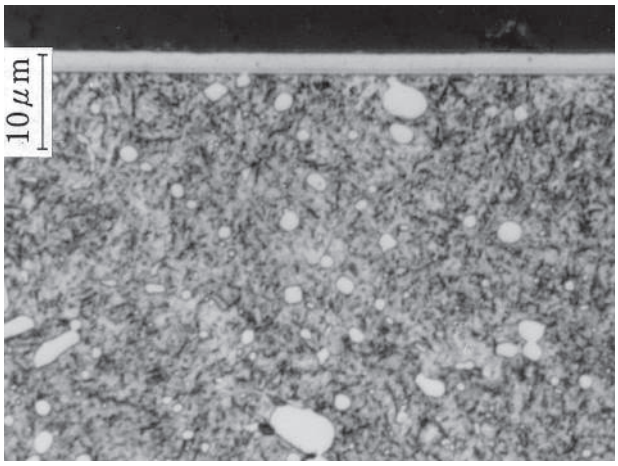
No.611 Sulpho-Nitriding (Low sulphur) (SCM435)



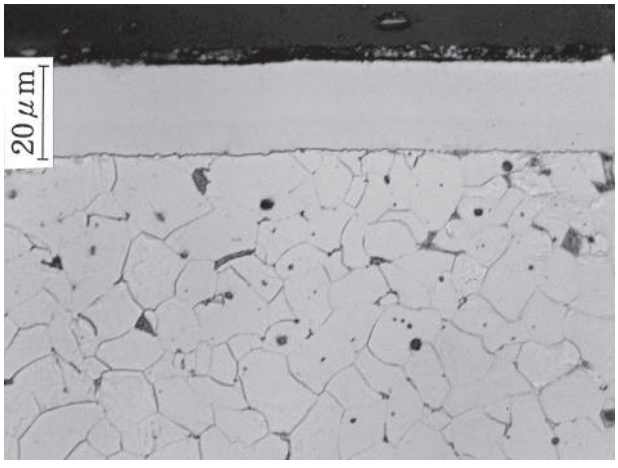
No.616 Carbide Coating (TD treatment) (SKD11)



No.619 PVD (physical vapor deposition) (SKD11)



No.623 Electroless Nickel Plating (SWY11)



Standard Microstructure　Group 7　Abnormal Structure

23types

Today, a variety of high-resolution microscopes and testing methods are available for testing, examining, and studying metallic materials, but optical microscopy and hardness tests are still in great demand in the industrial world. Conventionally, a microstructure sample usually meant a sample of the material's standard microstructure. However, many voices were heard at manufacturing sites, including those involved in heat treatment, asking for samples of defective microstructures, which are necessary to identify the causes of defects and to work out remedial measures. To achieve this, YSTL launched the development of standard samples of defective microstructures, with the cooperation and guidance of the people involved.
The samples shown here represent only a fraction of the possible defective microstructures, but we believe this is a significant attempt to respond to the voices of on-site industrial engineers.

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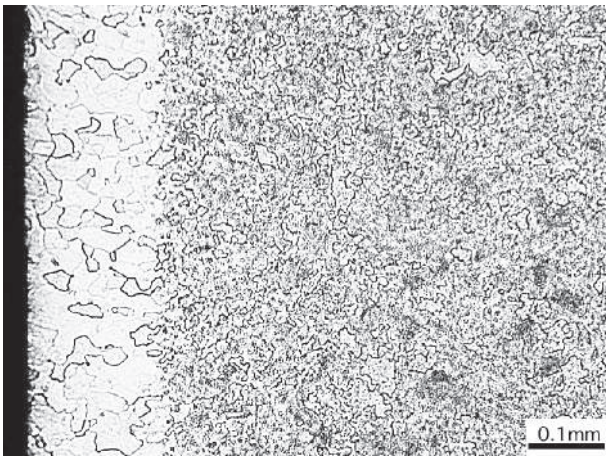
2-15-4, Sakae-cho, Funabashi-city, Chiba Pref., Japan　TEL ＋81－47－431－7451

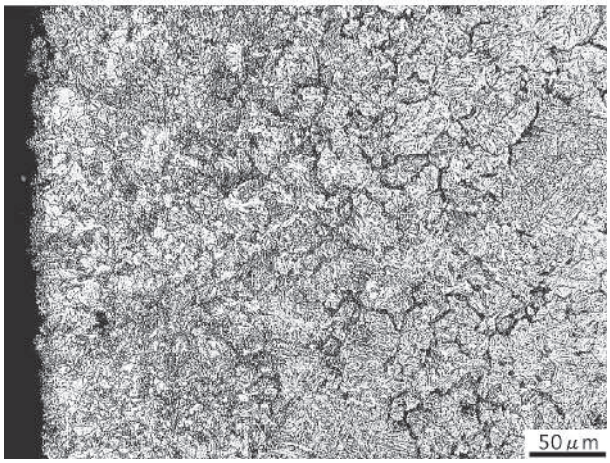
Sample No.	Micro Structure	Material (JIS)
701	Ferrite and Martensite	SCM440
702	Martensite and Fine Perlite	SK105
703	Martensite and Retained Austenite	SKS93
704	Undissolved Carbide and Martensite	SKD11
705	Carbide-Free Martensite	SUJ2
706	Coarse Martensite	SCM440
707	Fibrous Microstructure with Martensite	S45C
708	Carbide Segregation	SKD11
709	Mixed Grain Structure	SCM415
710	Microstructure Resulting From Overheating	SKS93
711	Microstructure Resulting From Burning	SKH51
712	Quench Cracking	SK85
713	Microstructure Resulting From Imperfect Tempering	SUS420J2
714	Microstructure Resulting From Imperfect Spheroidizing	SK85
715	Grain Boudary Oxidation	SCM415
716	Microstructure Resulting From Low Temperature Decarburizing	SK85
717	Microstructure After High Temperature Decarburizing Followed by Quenching	SK85
718	Excess Carburizing	SCM415
719	Inhomogeneous Nitriding	SCM435
720	Over-Nitriding	SACM645
721	Braunite	SPCC
722	Sensitization	SUS304
723	Abnormal Microstructure of a Spheroidal Graphite Cast Iron After Isothermal Transformation	FCD700
Annexes	Descriptions of the defective structures only. Samples not provided.	
Annex 1	Over Annealing	Former SKS1
Annex 2	Grinding Crack	SCM415
Annex 3	Melting	SCM440

No.716 Microstructure Resulting From Low Temperature Decarburizing



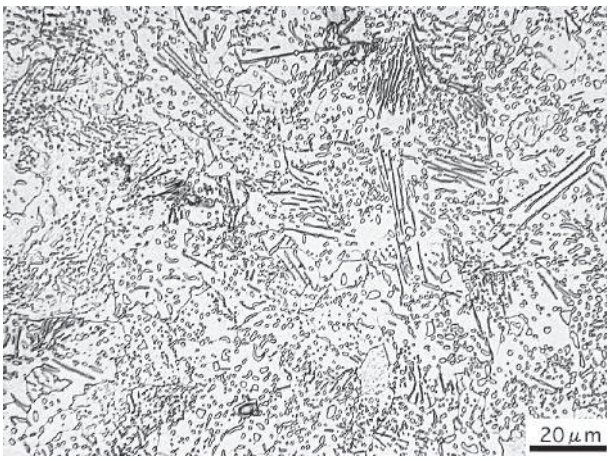
Seen in the photo to the left, the white band of about 0.2 mm in thickness represents a decarburized structure. To its right, you can see the spheroidal cementite structure of the base material. Because it is fully decarburized, the structure develops ferritic grain boundaries.
(Material:eutectoid carbon steel)

No.717 Microstructure After High Temperature Decarburizing Followed by Quenching



The white portion on the left side of the photo represents a decarburized layer.
Its underlying layer in black contains fine perlite and tempered martensite.
To its right, you can see tempered martensite alone.
(Material:eutectoid carbon steel)

No.714 Microstructure Resulting From Imperfect Spheroidizing



The matrix is ferrite, and the black lines and spheroidal parts represent cementite. You can see some bands of incompletely spherodized carbide.
(Material:eutectoid carbon steel)

BLOCKS FOR RELIABLE HARDNESS TEST

ISO 9001
JQA-2078

Based on ISO・JIS

Standard Blocks for Hardness

To improve tester performance before use

● Advantages Calibrating with the World's Most Accurate Blocks.

● The Most Consistent and Reliable commercially available in the world.

● Twice the Usable Test Areas.Thicker and More Stable

★New Product HRB Dual(HRB S+W):d-HRB 90,82,72,62,32

●Types and nominal Hardness Values

HR C	70,67,64,62,**60**
HR C	57,55,**50**,45,**40**,35,30,25,20,10
HR A	87,85,83,**81**,78,75,71,**65**,56
HR30N	83,**81**,78,73,**67**,60,55,50,41
HR15N(45N)	92,**90**,87,85,**80**,75(43)(23)
HRB S	100,95,**90**,82,72,**62**,52,**42**,32
★HRB Dual(HRB S+W) : d-HRB	**90**,82,72,**62**,32
HR30T S	78,72,62,**52**,42,38,32
HR15T S	87,82,**78**
HRE **90**,HRM 107,67,HRL 118,92,HRR 123,**105**,HRF 90,HRS 90	
HMV(1,0.1)	1600
HMV(1,0.1,0.01)	900,800,**700**,600,**500**,400,300,**200**,100,40
HMV(0.1,0.01,0.001)	30(Au)
HV(30,1)	1000,900,800,**700**
HV(10,1)	600,**500**,400,300,**200**,150,100,40
UMV(0.01,0.002)	900,700,500,200 (Berkovich 9.8mN tested)
★HN-W Single crystal block for nanoindentation (≃430HV 0.01,0.001,Berkovich 9.8mN tested)	
HS	100,95,**90**,80,70,**60**,50,40,**30**,20,7
HLE(Dia)	850,800,700,600,500
HLD(WC)	880,830,730,630,520
HBW(10/3000)	600,550,500,450.**400**,350
HBW(10/3000)	300,250,229(d=4mm),**200**,180,150
HBW(10/500)	125,100

● Combinations for diamond indenter verification

HR C 55,25 HR45N 43,23 HR15N 90

● Combinations for daily control

HR C 60,50,30
HS 90,60,30
HBW 229

Charpy V-Notch Test Blocks

In compliance with JIS B7740-1990
Feature:Extremely small irregularity in Charpy absorption energy(CV:3% or less)
Material:SNCM439.Q.T(complying with JIS test piece No.4)
NK verification provided.

	Energy Level
Type A	approx. 30J
Type B	approx. 100J
Type C	approx. 160J

5 pieces each energy levels per 1set

Standard Microstructure

Standard pieces of metal material microstructures and detailed explanations with photographs and CD-ROM.

Group 1.
Carbon steel,Cast iron
Group 2.
Alloy tool steel,
High-speed tool steel
Group 3.
Structural alloy steel,
steel for special use
Group 4.
Non-ferrous alloys
Group 6.
Metallic surface,
modifications
Group 1~6 25 types each
Group 7.
Abnormal structure
(23 types)

● A.G.S.ETCHING SET

Conforms to JIS 0551
Etching set for revealing the prior Austenite Grainboundaries of steels for structural use in machines.

Standard Piece for Spark Test

Based on JIS G 0566-1980 (Manual with CD-ROM)

For studying Grinding Spark Test for Steel.

Gr, "K"	Gr, "F"	Gr, "G"	Gr, "H"
SUY	SUY	SKS2	SNC631
S10C	S10C	SKS3	SNC415
S20C	S15C	SKS4	SNCM447
S45C	S20C	SKS93	SNCM420
SK105	S30C	SKD11	SCr440
SKS2	S35C	SKD4	SCr420
SKD11	S40C	SKD61	SCM440
SKD61	S45C	SKT4	SCM415
SKH55	S50C	SKH2	SUS410
SUJ2	S55C	SKH4	SUS420J2
SCM440	SK85	SKH51	SUS430
SCM415	SK105	SKH55	SUS304
SUS420J2	S10C(Carburized)	SKH57	SUS316
SUS304	SWRCH10R	SUJ2	SUH3
SUP6	FC30	SKS3	SUP6
(Educational)	(Carbon steel)	(Tool steel)	(Structural steel)

Hardnester

Standard File for Scratch Hardness

PAT. No. 196592 (Manual with DVD)

HRC 8 Hardness(20~67) HV 8 Hardness(200~900)
HV 16 Hardness(200~950)
with one T.M each Hardness value.

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