

# ALUMINUM ALLOYS

- **Aluminum** จัดเป็นโลหะที่มีการใช้งานมากเป็นอันดับที่สองรองจากเหล็ก
- **Classification and Temper designations of aluminum alloys**
  - **Wrought aluminum and Wrought aluminum alloys**
  - **Cast aluminum alloys**

## **Wrought aluminum alloy groups**

<b>Aluminum, 99.00% Al and greater</b>	<b>1xxx</b>
<b>Aluminum alloys grouped by major alloying elements Copper</b>	<b>2xxx</b>
<b>Si, with added Cu and or Mg</b>	<b>3xxx</b>
<b>Si</b>	<b>4xxx</b>
<b>Mg</b>	<b>5xxx</b>
<b>Zn</b>	<b>7xxx</b>
<b>Sn</b>	<b>8xxx</b>
<b>Other element</b>	<b>9xxx</b>
<b>Unused series</b>	<b>6xxx</b>

# Cast aluminum alloy groups

<b>Aluminum, 99.00% Al and greater</b>	<b>1xxx</b>
<b>Aluminum alloys grouped by major alloying elements Copper</b>	
<b>Cu</b>	<b>2xxx</b>
<b>Mn</b>	<b>3xxx</b>
<b>Si</b>	<b>4xxx</b>
<b>Mg</b>	<b>5xxx</b>
<b>Mg and Si</b>	<b>6xxx</b>
<b>Zn</b>	<b>7xxx</b>
<b>Other element</b>	<b>8xxx</b>
<b>Unused series</b>	<b>9xxx</b>

# Chemical composition and applications of commercially pure aluminum alloys

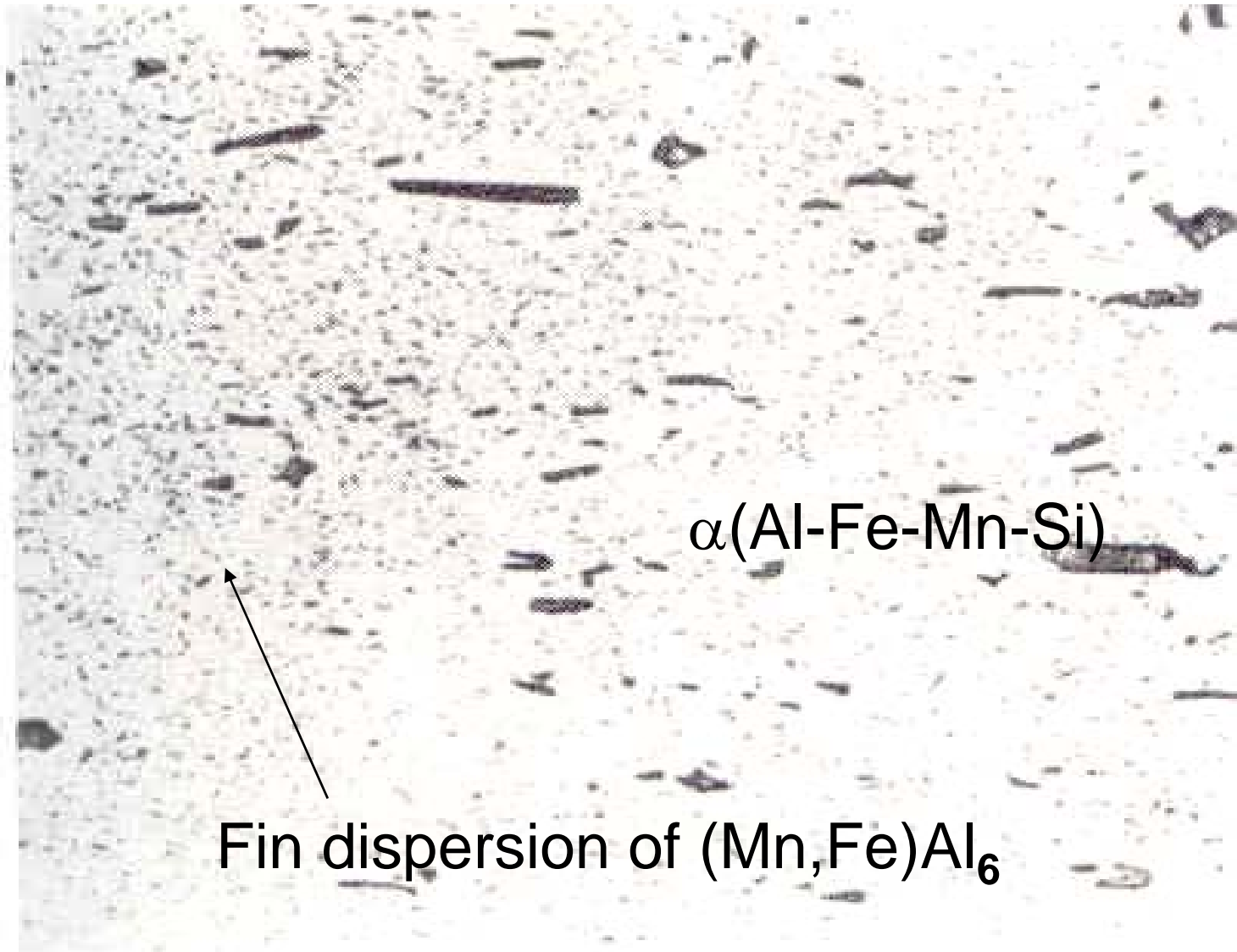
<b>Alloy</b>	<b>%Purity</b>	<b>%Si</b>	<b>%Fe</b>	<b>%Cu</b>	<b>Applications</b>
<b>1050</b>	<b>99.50</b>	<b>0.25</b>	<b>0.40</b>	<b>0.05</b>	<b>Coiled tubing,extruded</b>
<b>1060</b>	<b>99.60</b>	<b>0.25</b>	<b>0.35</b>	<b>0.05</b>	<b>Chemical equipment;railroad tank cars</b>
<b>1100</b>	<b>99.00</b>	<b>1.0 Si+Fe</b>	<b>-</b>	<b>0.12nom.</b>	<b>Sheet metal work;spun hollow ware;fin stock</b>
<b>1145</b>	<b>99.45</b>	<b>0.55 Si+Fe</b>	<b>-</b>	<b>0.05</b>	<b>Foil for capacitors;fin stock</b>
<b>1175</b>	<b>99.75</b>	<b>0.15 Si+Fe</b>	<b>-</b>	<b>0.10</b>	<b>Reflector sheet</b>
<b>1200</b>	<b>99.00</b>	<b>1.0 Si+Fi</b>	<b>-</b>	<b>0.05</b>	<b>Coiled tubing, extruded;sheet metal work</b>
<b>1230</b>	<b>99.30</b>	<b>0.7 Si+Fe</b>	<b>-</b>	<b>0.10</b>	<b>Cladding for sheets and plates</b>
<b>1235</b>	<b>99.35</b>	<b>0.65 Si+Fe</b>	<b>-</b>	<b>0.05</b>	<b>Foil for capacitors;tubing</b>
<b>1345</b>	<b>99.45</b>	<b>0.30</b>	<b>0.40</b>	<b>0.10</b>	<b>-</b>
<b>1350</b>	<b>99.50</b>	<b>0.10</b>	<b>0.40</b>	<b>0.05</b>	<b>Electrical conductors</b>

## ตารางคุณสมบัติทางกลและการใช้งานในเชิงพาณิชย์

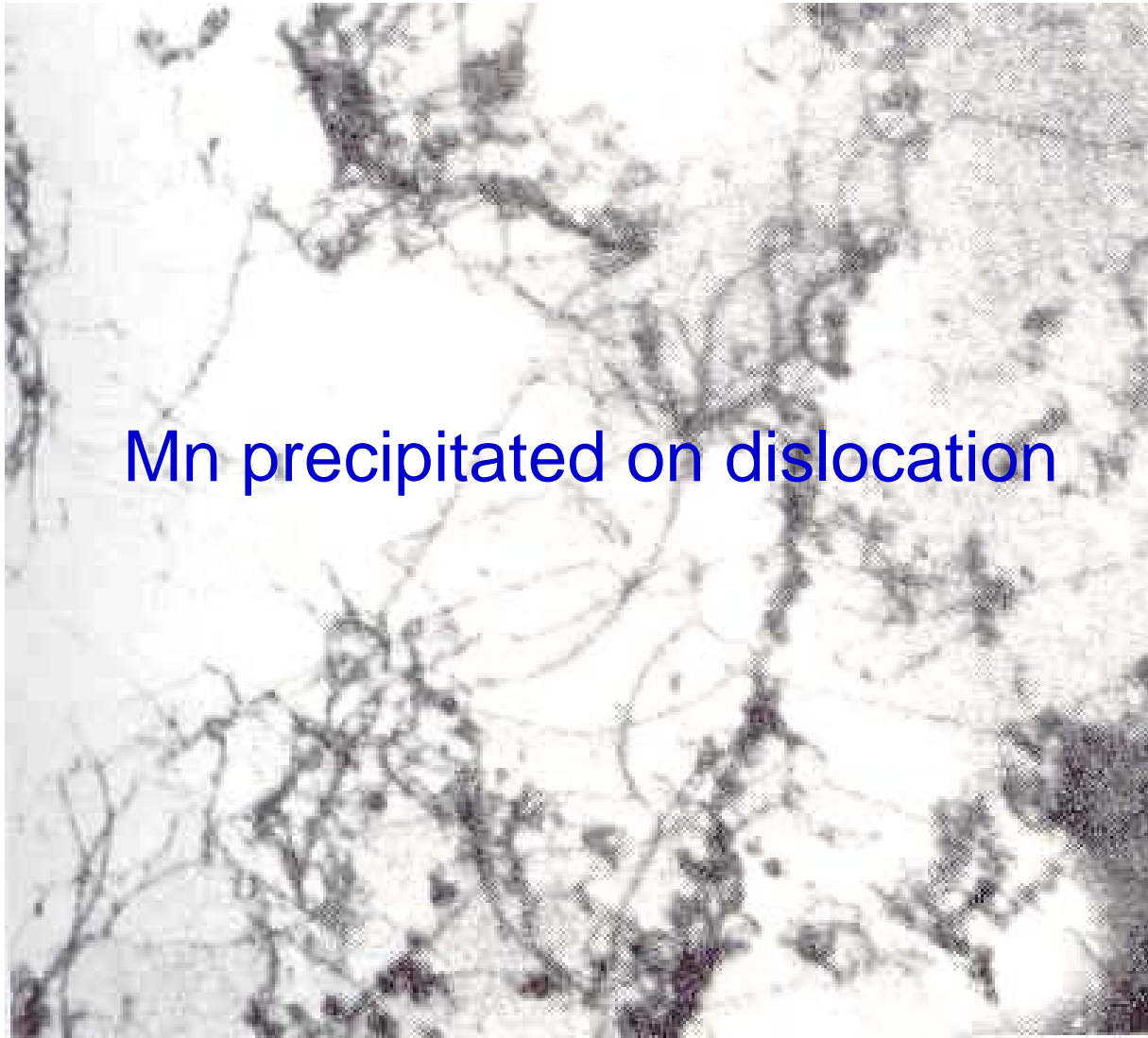
**TABLE 5-5**  
**Typical mechanical properties of commercially pure aluminum**

Alloy	Temper	Tensile strength, psi	Tensile yield strength,* psi	Elongation, % in 2 in	Hardness, <sup>†</sup> Bhn	Shear strength, psi	Fatigue limit, <sup>‡</sup> psi
1199	O	6,500	1,500	50			
	H18	17,000	16,000	5			
1180	O	9,000	3,000	45			
	H18	18,000	17,000	5			
1060	O	10,000	4,000	43	19	7,000	3000
	H14	14,000	13,000	12	26	9,000	5000
	H18	19,000	18,000	6	35	11,000	6500
EC	O	12,000	4,000	23 <sup>§</sup>		8,000	
	H14	16,000	14,000			10,000	
	H19	27,000	24,000	2.5 <sup>§</sup>		15,000	
1145	O	11,000	5,000	40		8,000	
	H18	21,000	17,000	5		12,000	
1100	O	13,000	5,000	35	23	9,000	5000
	H14	18,000	17,000	9	32	11,000	7000
	H18	24,000	22,000	5	44	13,000	9000

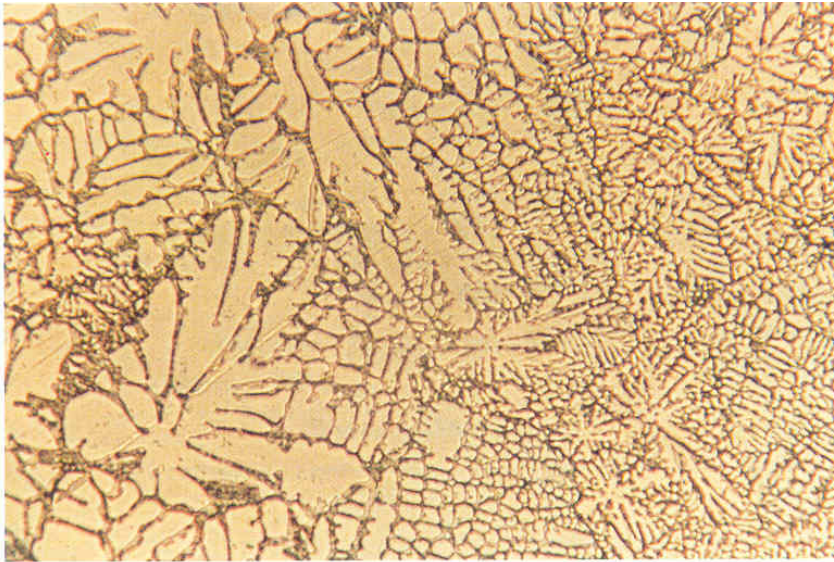
# โครงสร้างจุลภาคของ Al alloy 3003(1.2%Mn) annealed sheet



**โครงสร้างจุลภาคของ Al alloy 3003(1.2%Mn)preheated at 543° C cold-rolled 80%,annealed at 343° C for 250 s.**

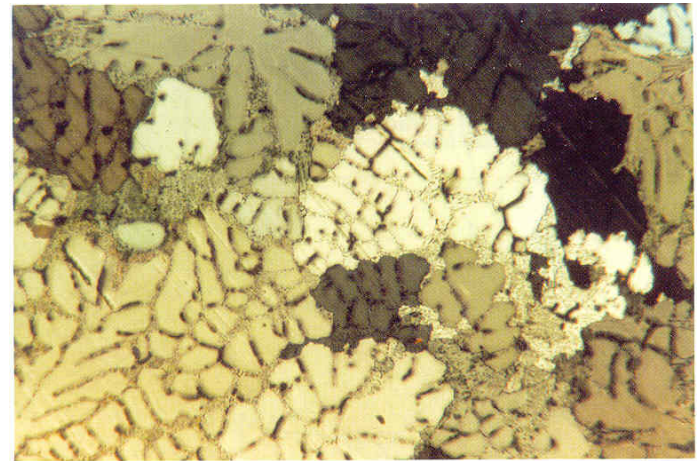


# Al-Mn-Al3003 cooling rate of 1.2°C/s.

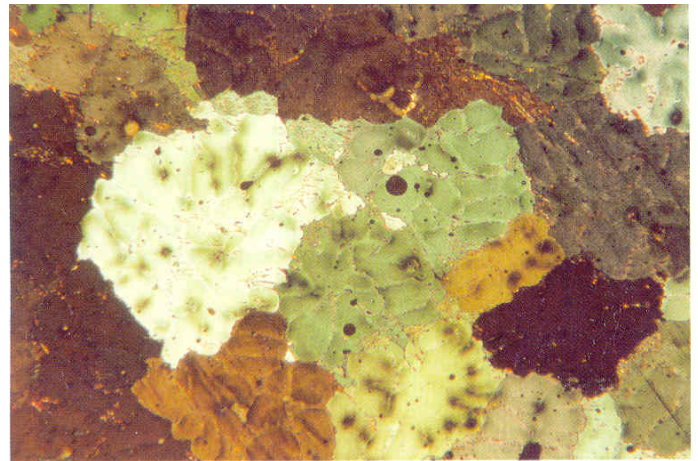


A

ปล่อยให้แข็งตัวในเวลาต่างกันก่อนนำไปชุบ  
ชุบ ถ่ายที่กำลังขยาย **55** เท่า



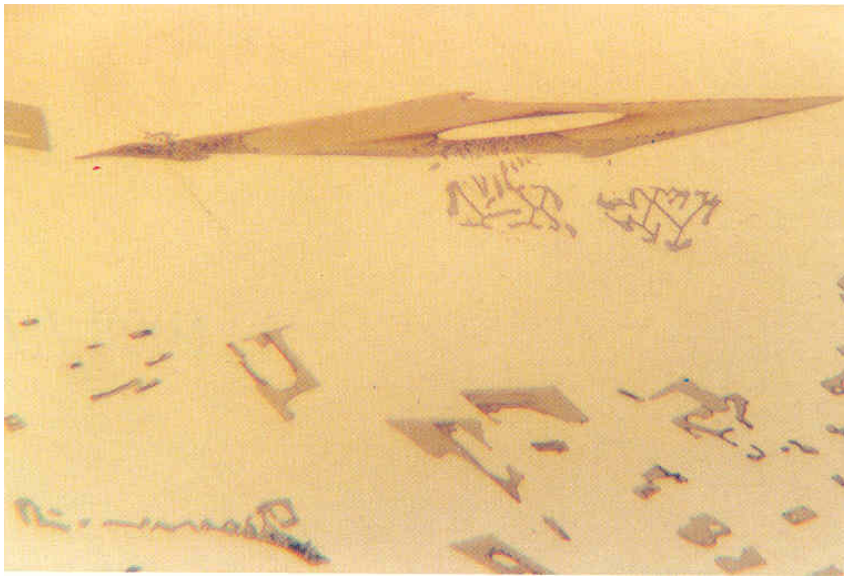
B



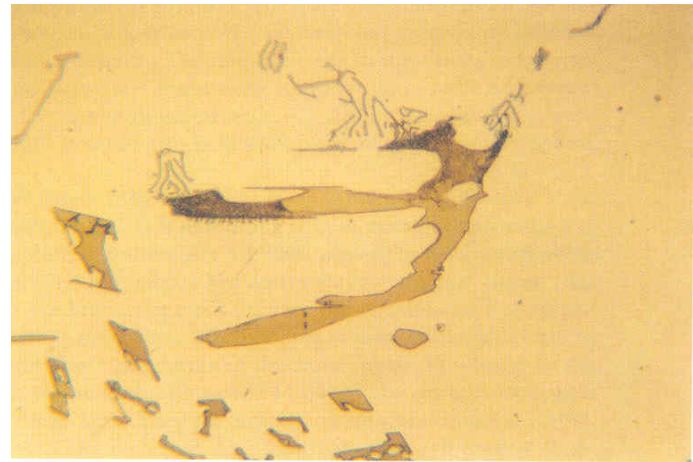
C



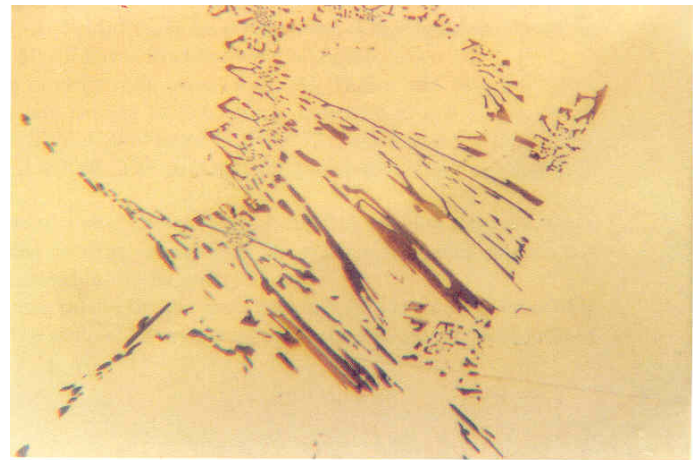
**Al3003 showing  $Al_6(FeMn)$  and  $Al_{15}(FeMn)_3Si_2$  Cooling rate:  $0.5^\circ C/s$  กำลังขยาย 550 เท่า**



A



B



C

TABLE 5-7

Typical mechanical properties of non-heat-treatable aluminum-manganese and aluminum-manganese-magnesium alloys

Alloy	Temper	Tensile strength, psi	Tensile yield strength, psi	Elongation, % in 2 in	Hardness, Bhn	Shear strength, psi	Fatigue limit, psi
3003	O	16,000	6,000	30	28	11,000	7,000
	H14	22,000	21,000	8	40	14,000	9,000
	H18	29,000	27,000	4	55	16,000	10,000
3004	O	26,000	10,000	20	45	16,000	14,000
	H34	35,000	29,000	9	63	18,000	16,000
	H38	41,000	36,000	5	77	21,000	18,000
3005	O	19,000	8,000	25	..	12,000	
	H18	35,000	33,000	4	..	18,000	
3105	H25	26,000	24,000	8	..	16,000	

1 ksi = 6.89 MPa.

# ALUMINUM-MAGNESIUM ALLOYS

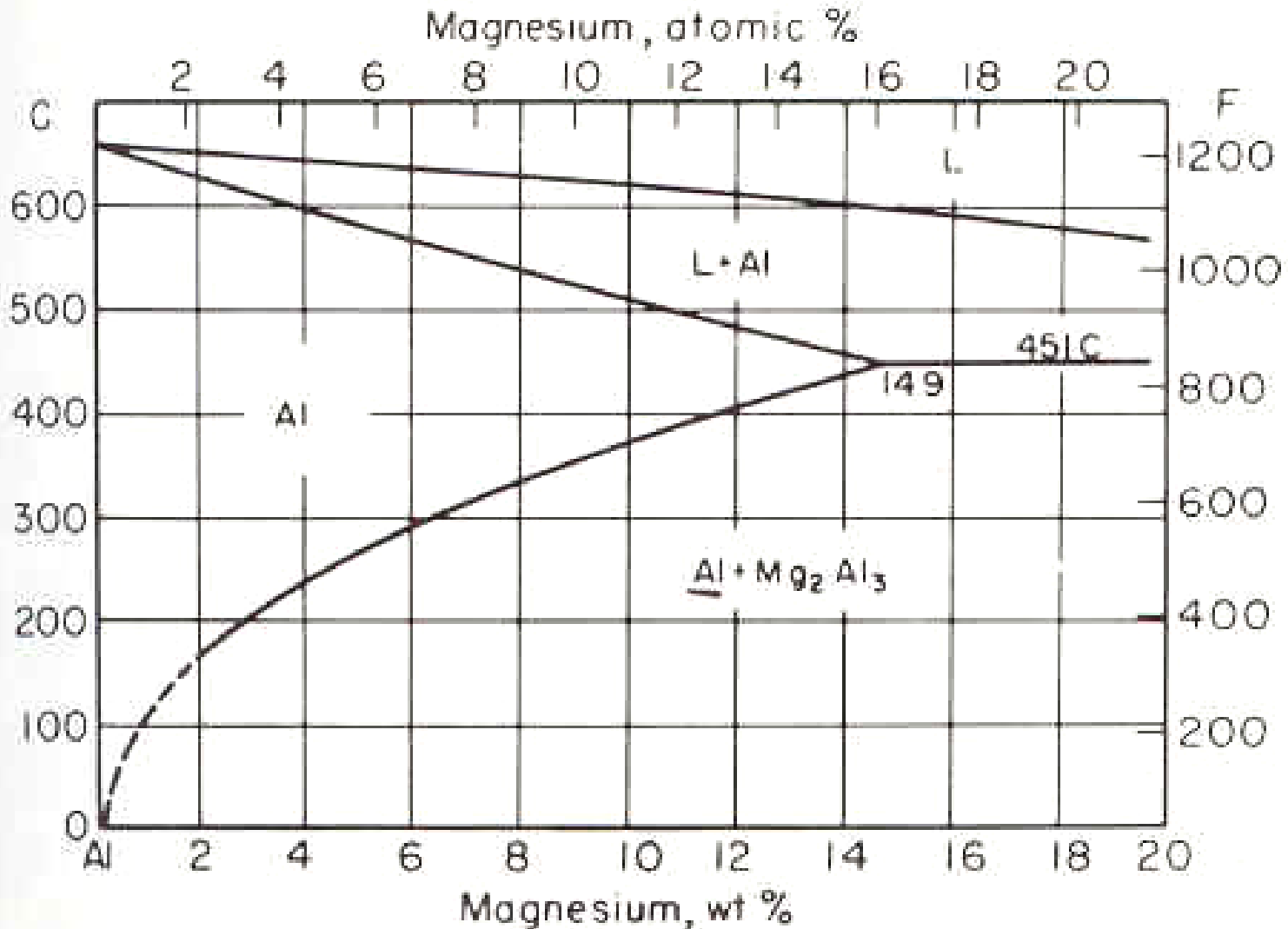


TABLE 5-8

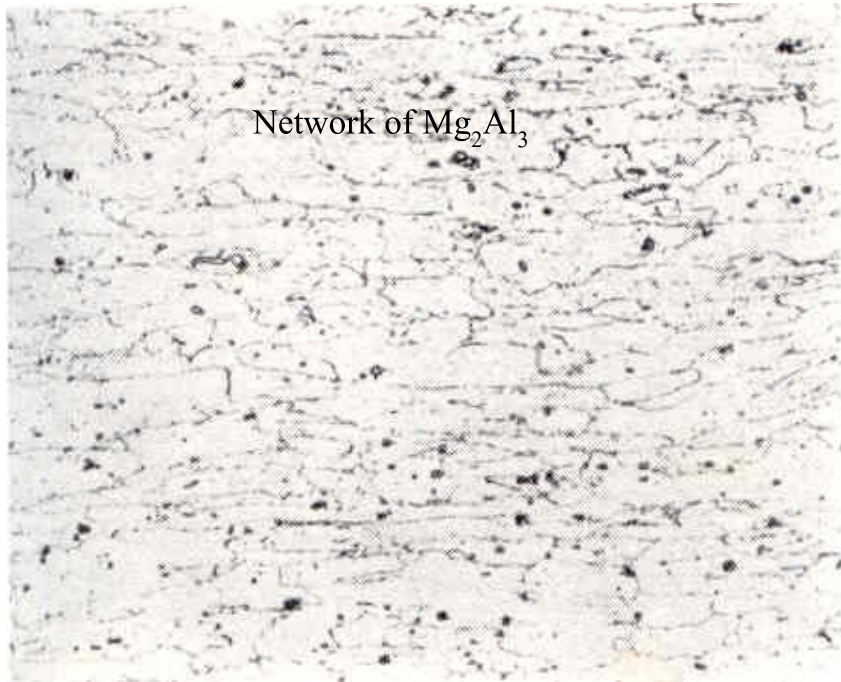
## Chemical compositions and applications of aluminum-magnesium alloys\*

Alloy	% Composition	Applications
5005	0.8 Mg	Appliances; utensils; architectural trim; electrical conductors
5050	1.4 Mg	Builders' hardware; refrigerator trim; coiled tubes
5052	2.5 Mg, 0.25 Cr	Sheet metal work; hydraulic tubes; appliances; bus, truck and marine uses
5056	0.12 Mn, 5.1 Mg, 0.12 Cr	Cable sheathing; rivets for magnesium; screen wire; zippers
5083	0.7 Mn, 4.45 Mg, 0.15 Cr	{ Unfired, welded pressure vessels; marine, auto, and aircraft parts; cryogenics; TV towers; drilling rigs; transportation equipment; missile components; armor plate
5086	0.45 Mn, 4.0 Mg, 0.15 Cr	
5154	3.5 Mg, 0.25 Cr	Welded structures; storage tanks; pressure vessels; salt-water service
5252	2.5 Mg	Auto and appliance trim
5254	3.5 Mg, 0.25 Cr	Hydrogen peroxide and chemical storage vessels
5356	0.12 Mn, 5.0 Mg, 0.12 Cr	Welding rod, wire, and electrodes
5454	0.8 Mn, 2.7 Mg, 0.12 Cr	Welding structures; pressure vessels; marine service; tubing
5456	0.8 Mn, 5.1 Mg, 0.12 Cr	High-strength welded structures; storage tanks; pressure vessels; marine service
5457	0.3 Mn, 1.0 Mg	Anodized auto and appliance trim (good formability in annealed temper)
5652	2.5 Mg, 0.25 Cr	Hydrogen peroxide and chemical storage vessels
5657	0.8 Mg	Anodized auto and appliance trim (good brightness)

\* After "ASM Databook," published in *Met. Prog.*, vol. 116, no. 1, mid-June 1979.

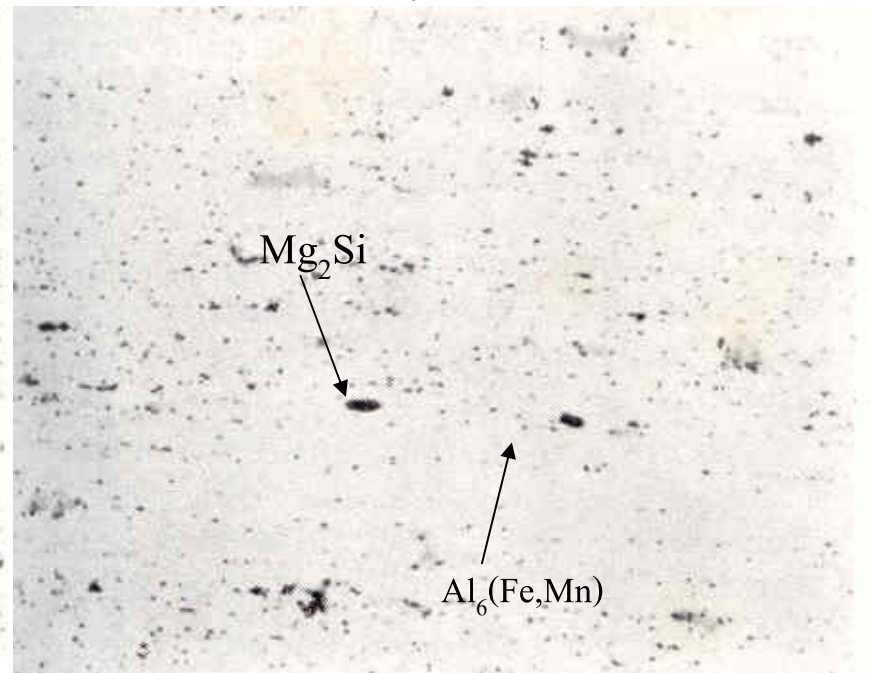
# ALUMINUM-MAGNESIUM ALLOYS

Alloy 5086-H43



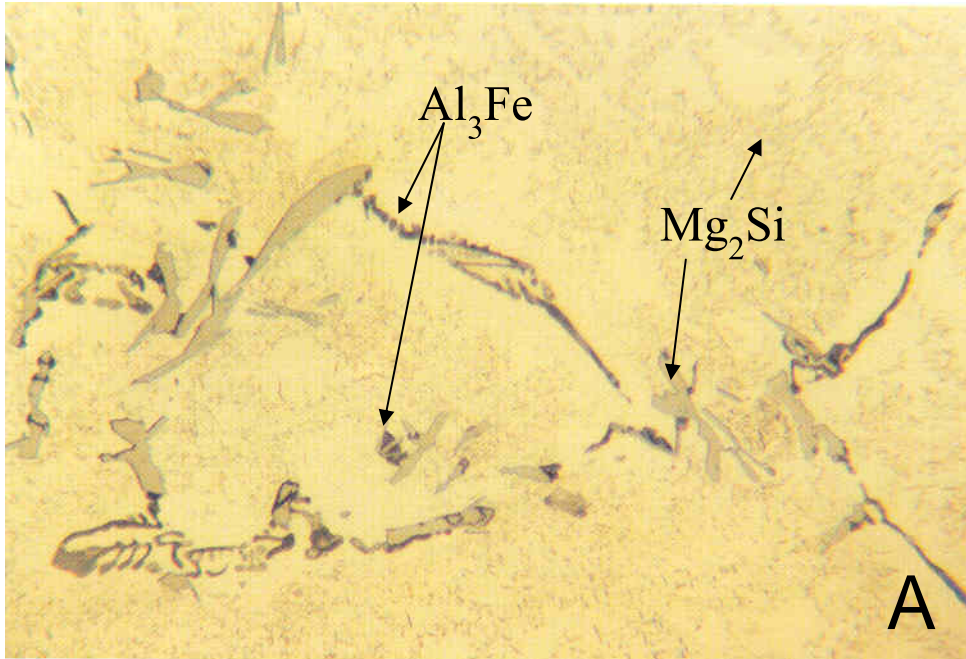
A

Alloy 5456

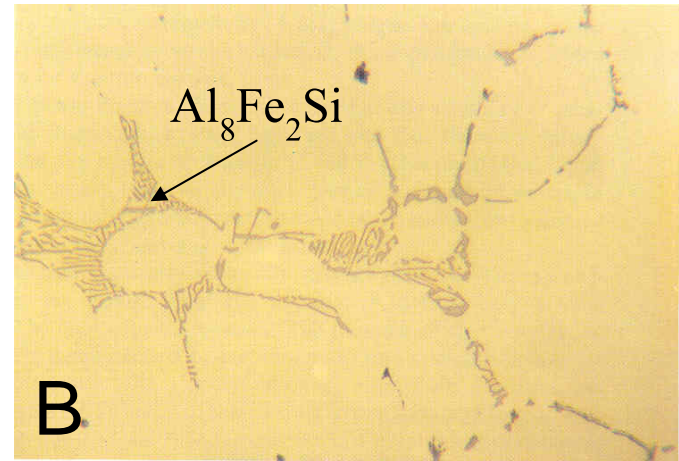


B

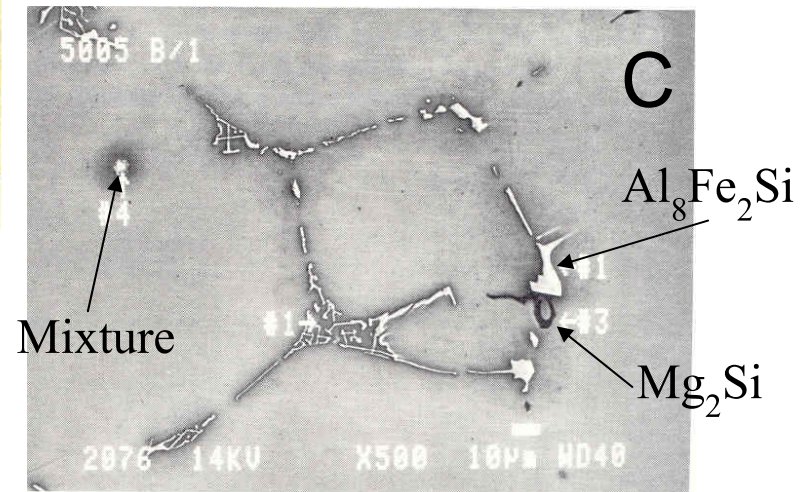
# Al-Mg alloy-AA5005



Cooling rate:0.3°C/s กำลังขยาย 550 เท่า



Cooling rate:3.3°C/s



# Aluminum-Copper alloys

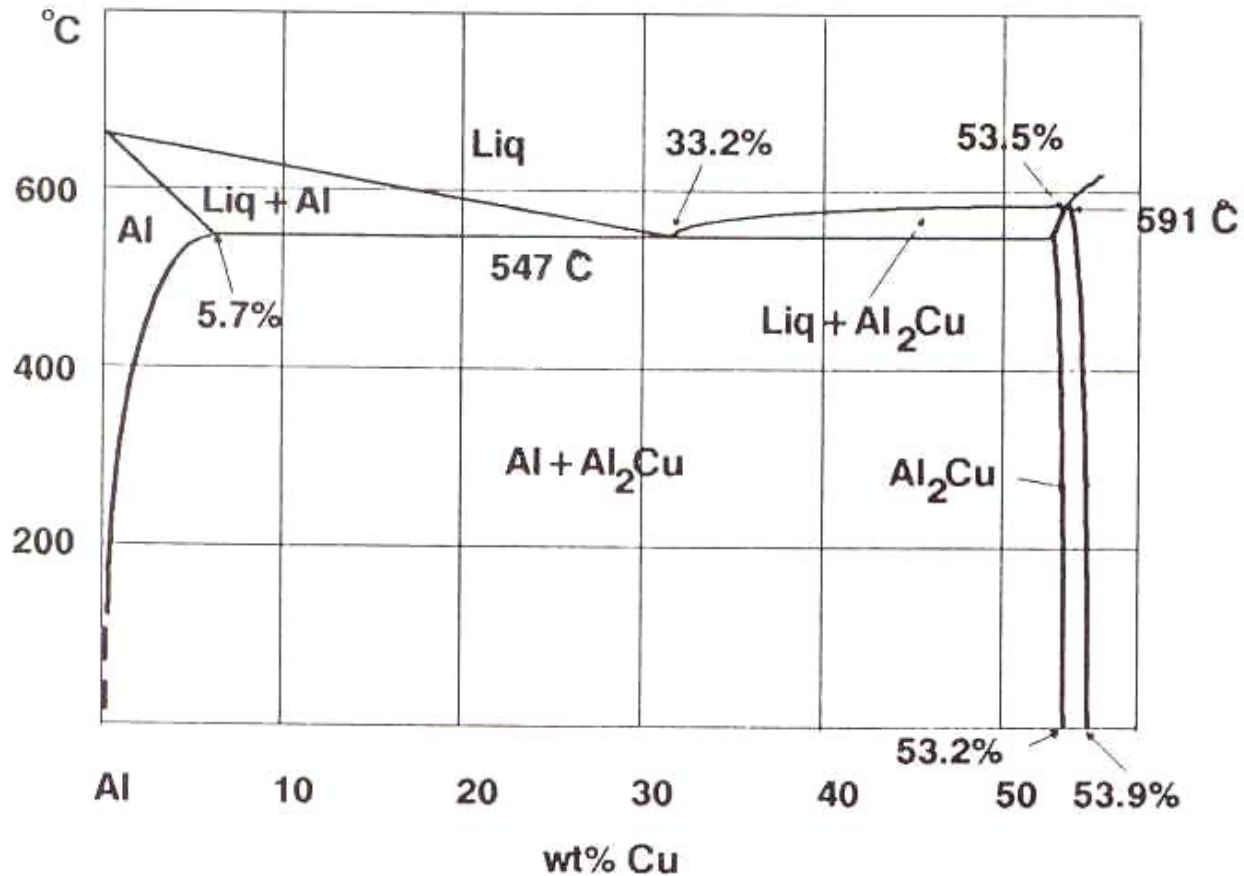


Figure 1. *The aluminum end of the aluminum-copper equilibrium diagram (after Mondolfo, [1976]).*

## Chemical compositions and applications of Al-Cu alloys

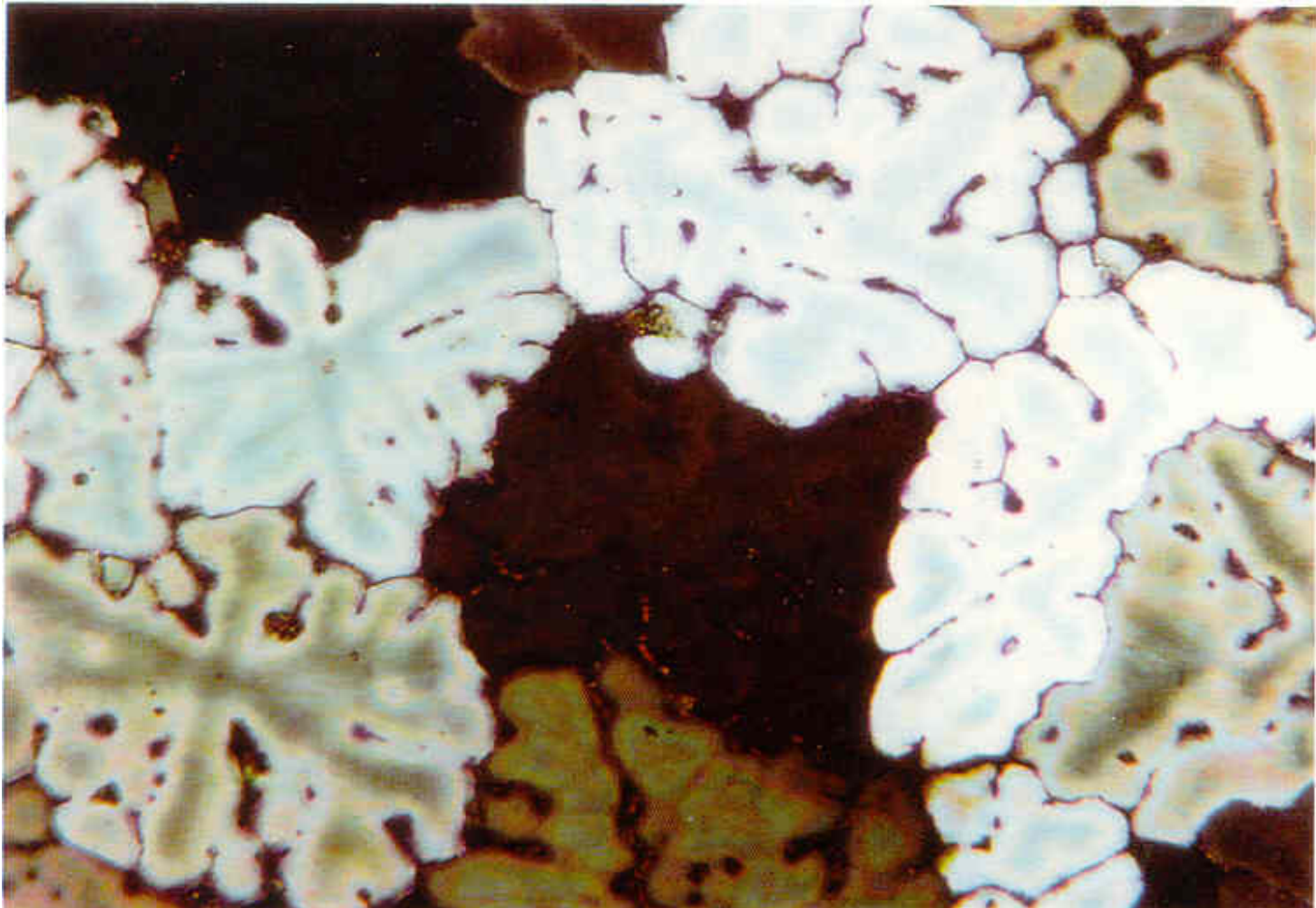
<b>Alloy</b>	<b>%Cu</b>	<b>%Mn</b>	<b>%Other</b>	<b>Applications</b>
<b>2011</b>	<b>5.5</b>	<b>-</b>	<b>0.4 Bi,0.4 Pb</b>	<b>Screw-machine products</b>
<b>2025</b>	<b>4.5</b>	<b>0.8</b>	<b>0.8 Si</b>	<b>Forgings, aircraft products</b>
<b>2219</b>	<b>6.3</b>	<b>0.3</b>	<b>0.06Ti,0.10V,0.18 Zr</b>	<b>Structural use to 660°F, high strength weldments for cryogenic and aircraft parts</b>
<b>2419</b>	<b>6.3</b>	<b>0.3</b>	<b>0.06Ti,0.10V,0.18 Zr</b>	<b>Same as 2219 plus high fracture toughness</b>



# Al-Cu-201.2

Si=0.02,Fe=0.01,Cu=4.10,Mn=0.31,Ti=0.19,Ag=0.51

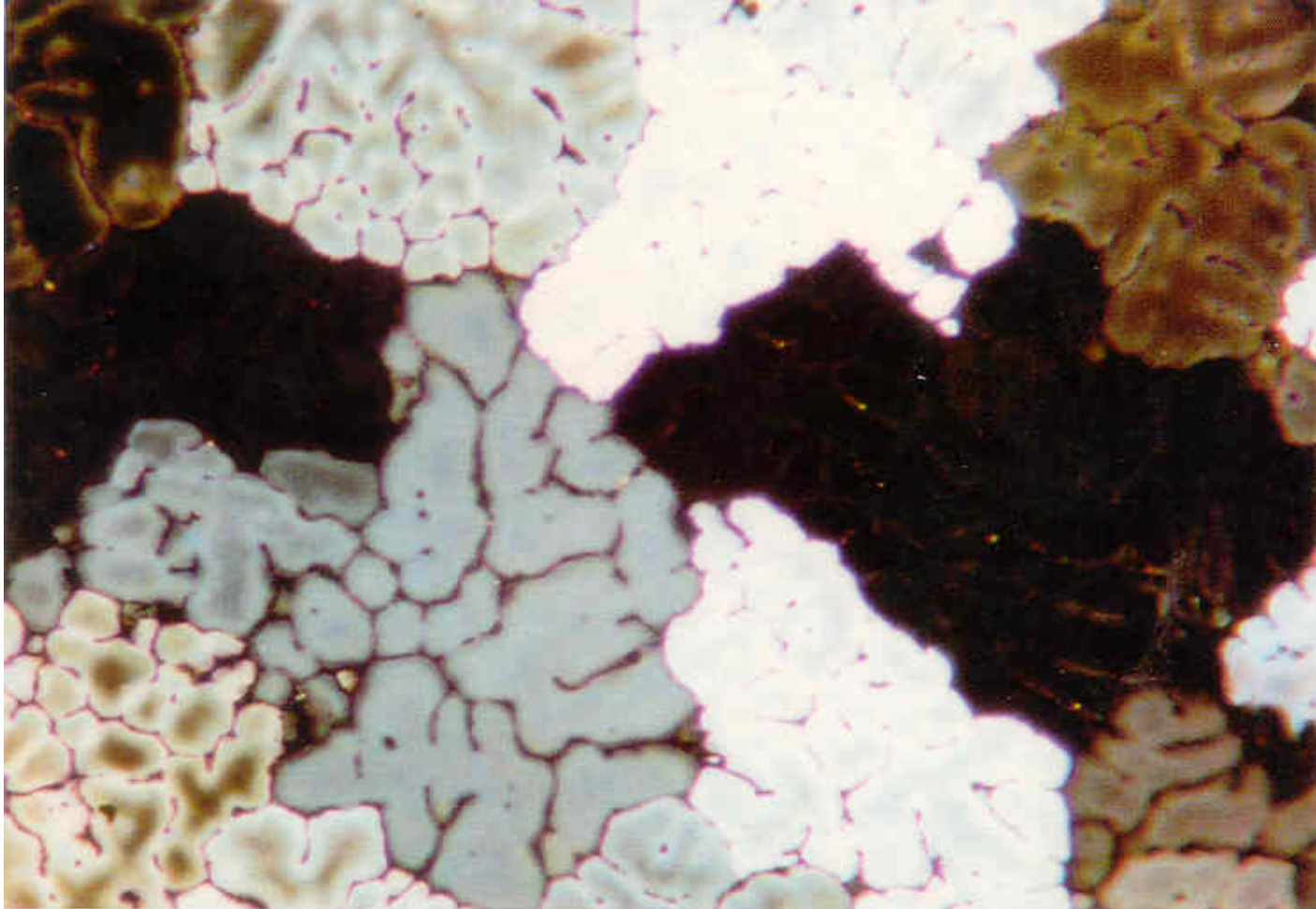
Cooling rate 0.3°C/s กำลังขยาย 56 เท่า



# Al-Cu-201.2

Si=0.02,Fe=0.01,Cu=4.10,Mn=0.31,Ti=0.19,Ag=0.51

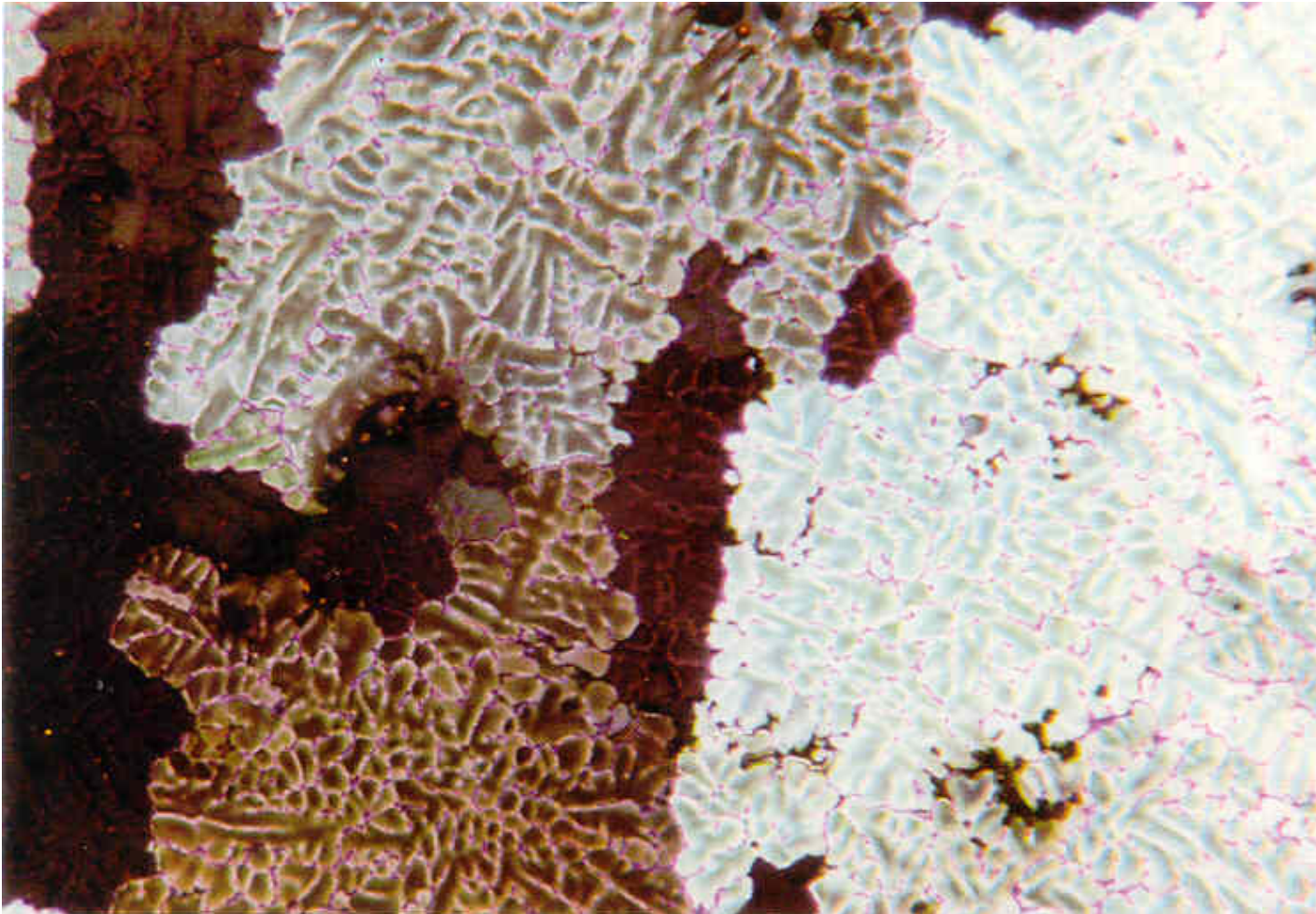
Cooling rate 0.6 °C/s กำลังขยาย 56 เท่า



# Al-Cu-201.2

Si=0.02,Fe=0.01,Cu=4.10,Mn=0.31,Ti=0.19,Ag=0.51

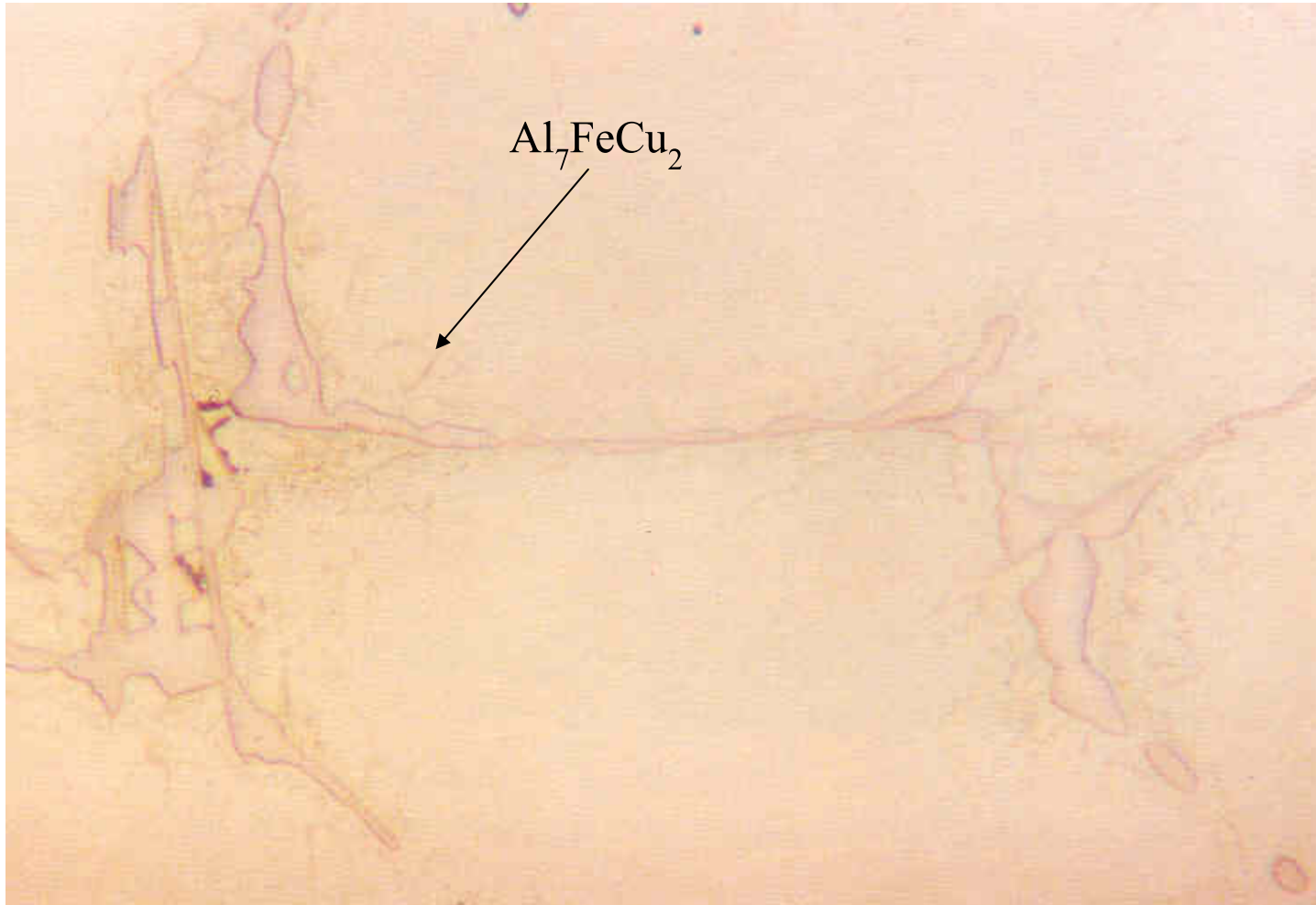
Cooling rate 4.4°C/s กำลังขยาย 56 เท่า



# Al-Cu-201.2

Si=0.02, Fe=0.01, Cu=4.10, Mn=0.31, Ti=0.19, Ag=0.51

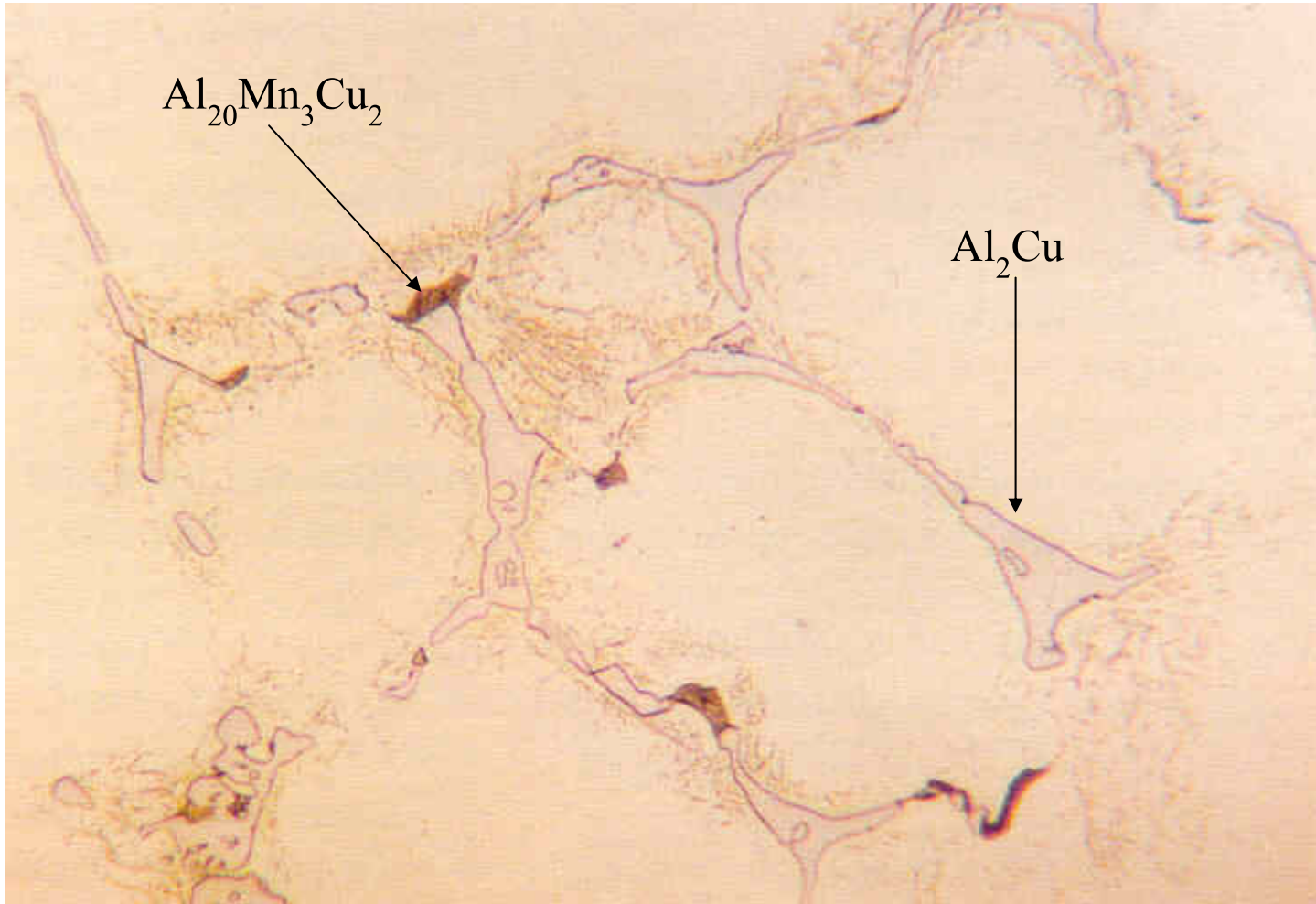
Cooling rate 0.3 °C/s กำลังขยาย 560 เท่า



# Al-Cu-201.2

Si=0.02,Fe=0.01,Cu=4.10,Mn=0.31,Ti=0.19,Ag=0.51

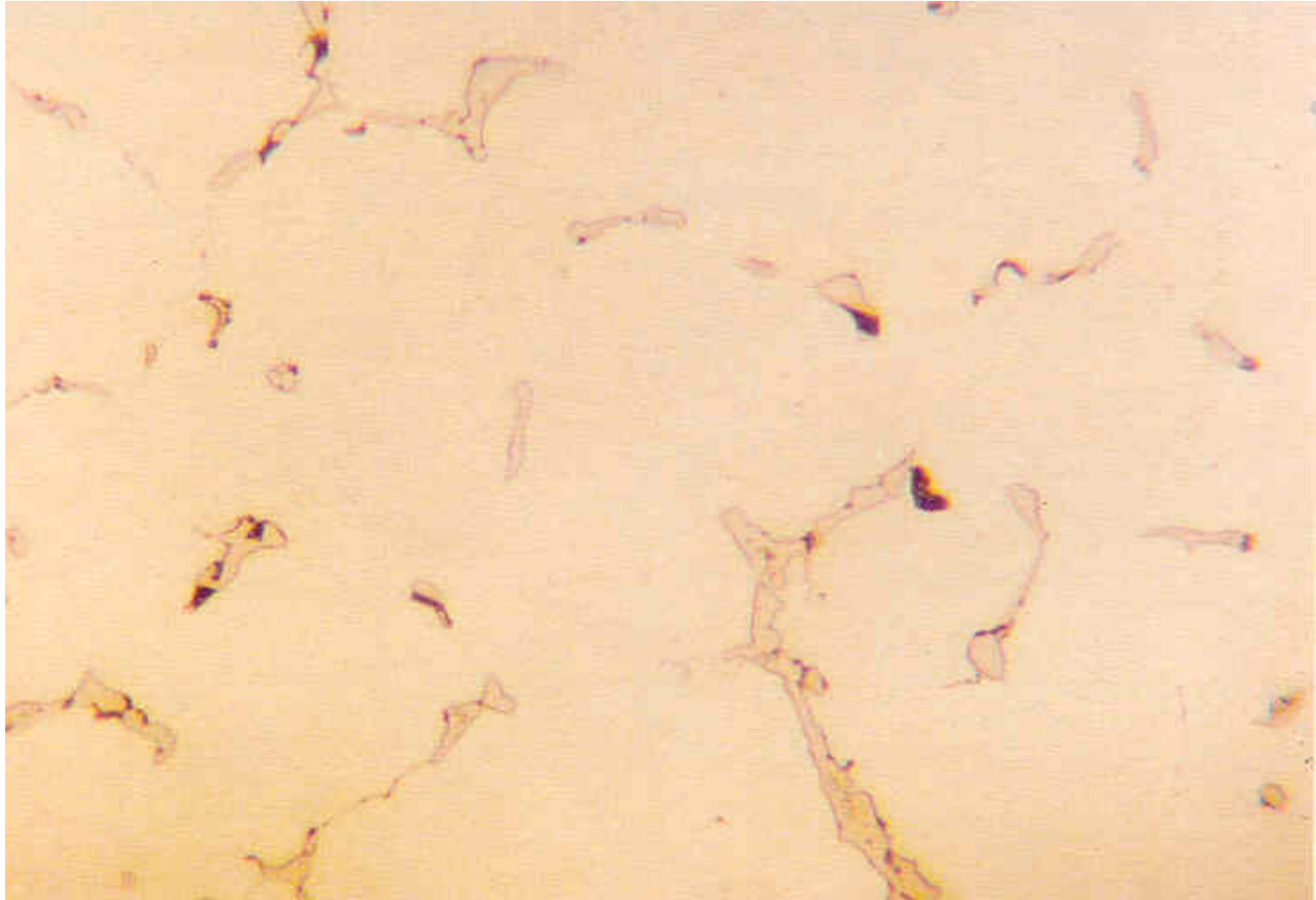
Cooling rate 0.6 °C/s กำลังขยาย 560 เท่า



# Al-Cu-201.2

Si=0.02,Fe=0.01,Cu=4.10,Mn=0.31,Ti=0.19,Ag=0.51

Cooling rate 4.4 °C/s กำลังขยาย 560 เท่า



# Aluminum-Silicon alloys

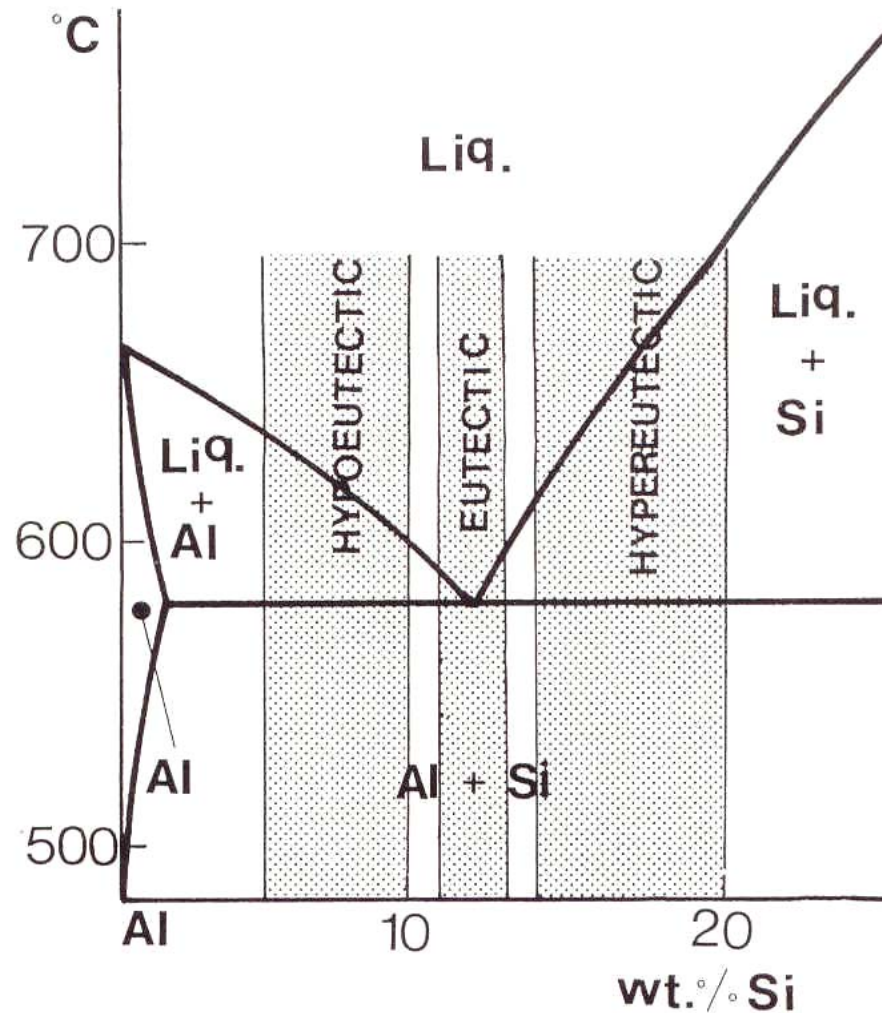
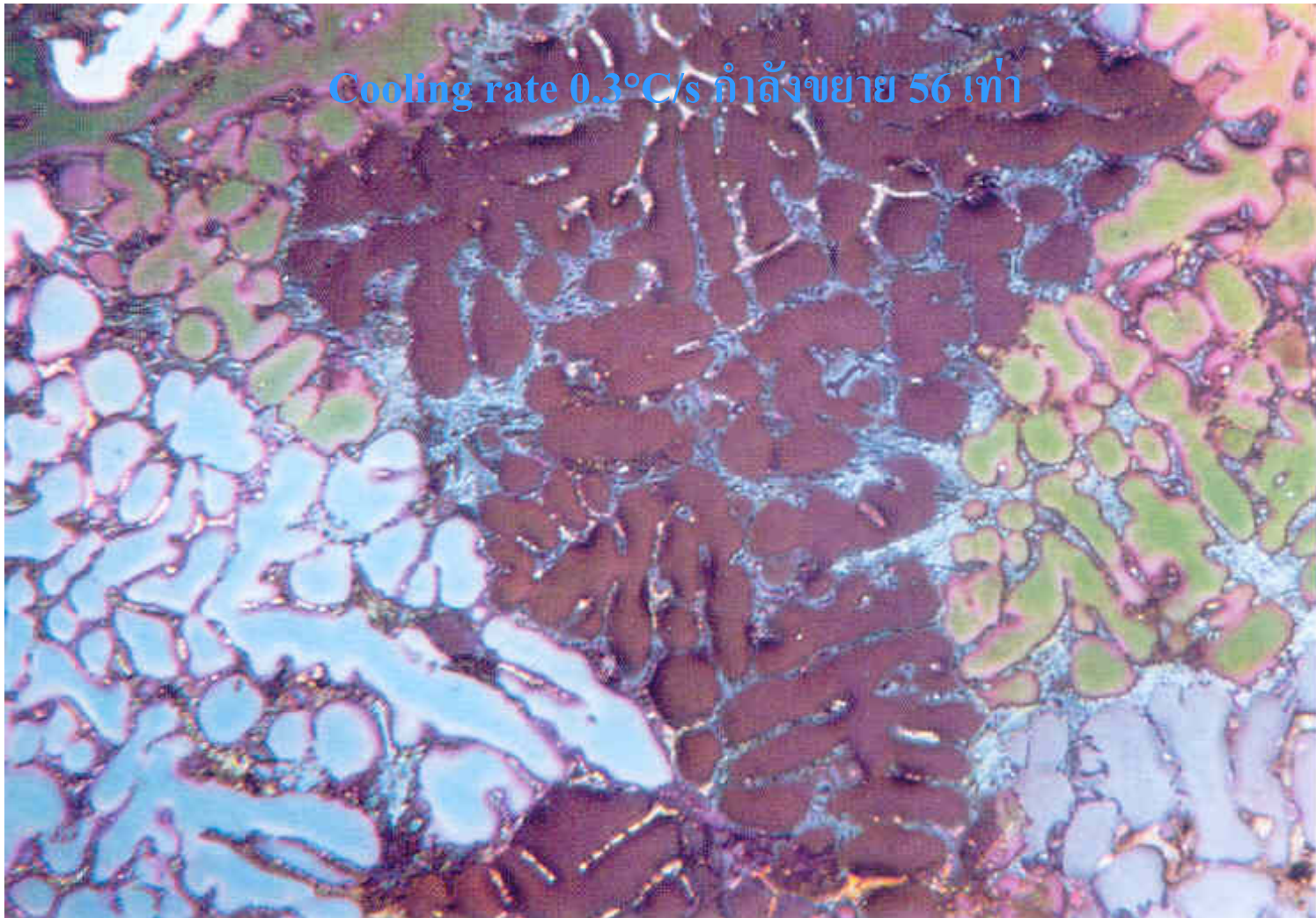


Figure 1. Part of the Al-Si phase diagram showing composition ranges of various alloy types.

# Al alloy-319.1

Si=5.7,Fe=0.62,Cu=3.4,Mn=0.36,Mg=0.10,Zn=0.92,Ti=0.14

Cooling rate 0.3°C/s กำล้างขยาย 56 เท่า

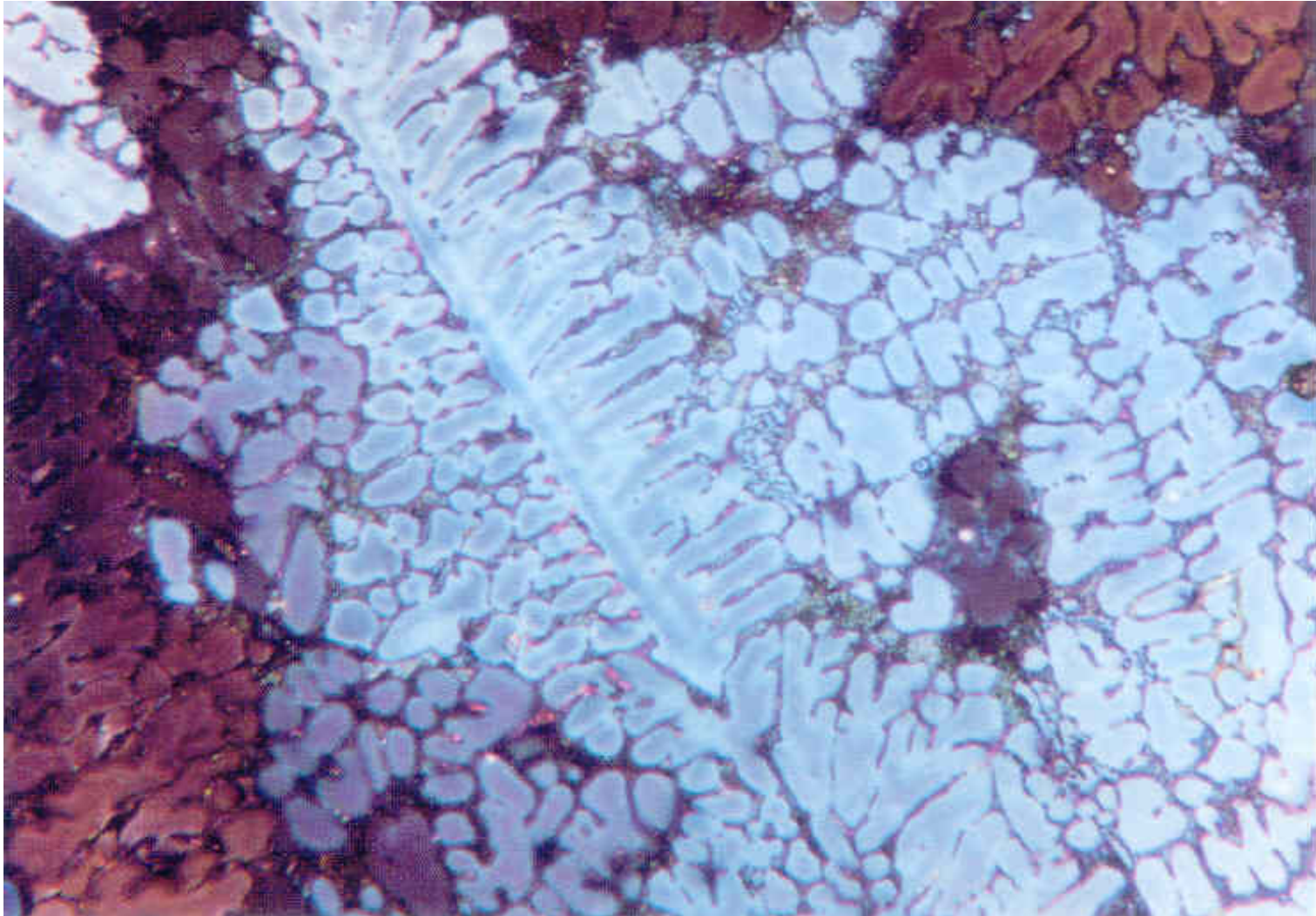




# Al alloy-319.1

Si=5.7,Fe=0.62,Cu=3.4,Mn=0.36,Mg=0.10,Zn=0.92,Ti=0.14

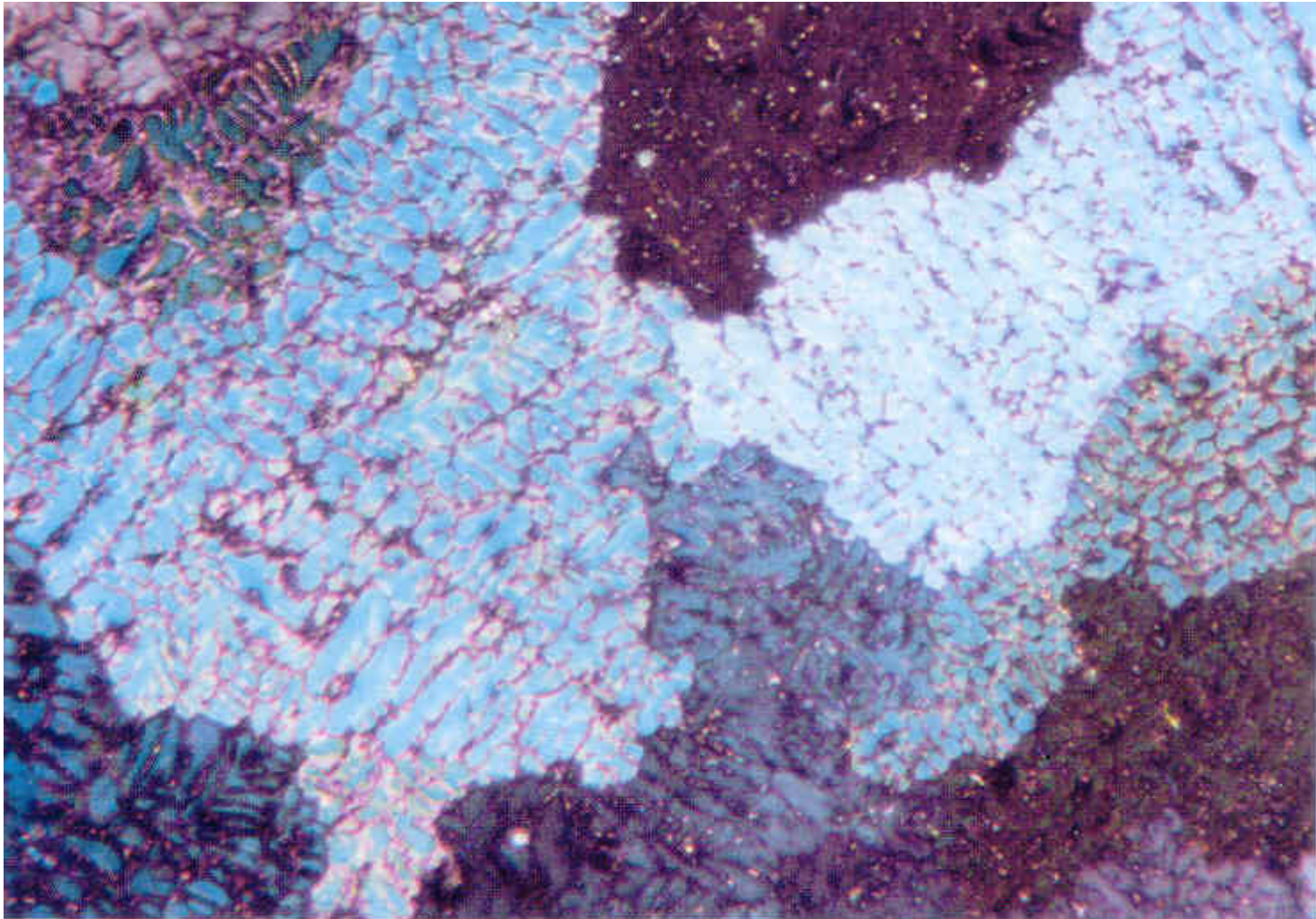
Cooling rate  $0.6^{\circ}\text{C/s}$  กำลังขยาย 56 เท่า



# Al alloy-319.1

Si=5.7,Fe=0.62,Cu=3.4,Mn=0.36,Mg=0.10,Zn=0.92,Ti=0.14

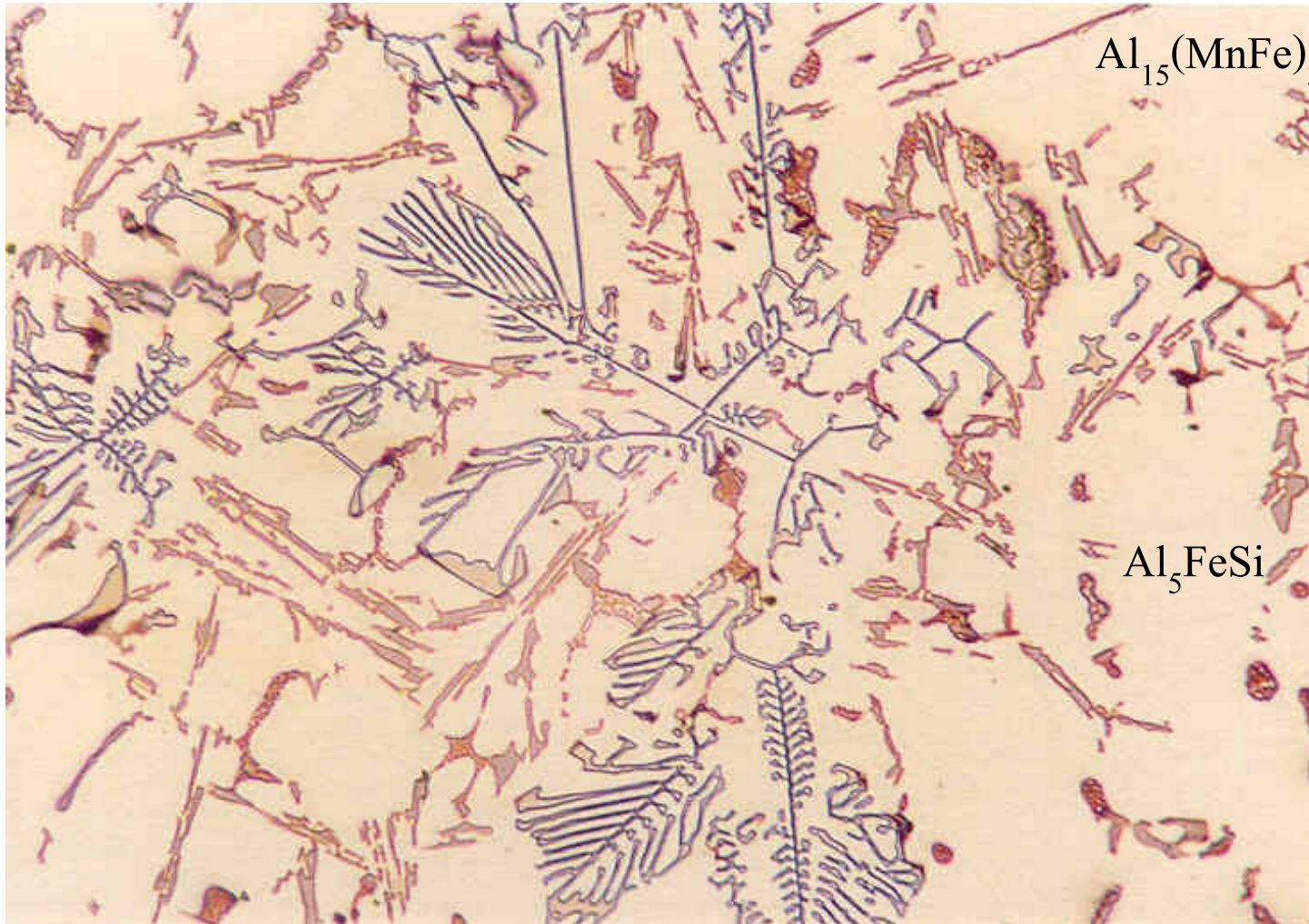
Cooling rate 5°C/s กำลังขยาย 56 เท่า



# Al alloy-319.1

Si=5.7,Fe=0.62,Cu=3.4,Mn=0.36,Mg=0.10,Zn=0.92,Ti=0.14

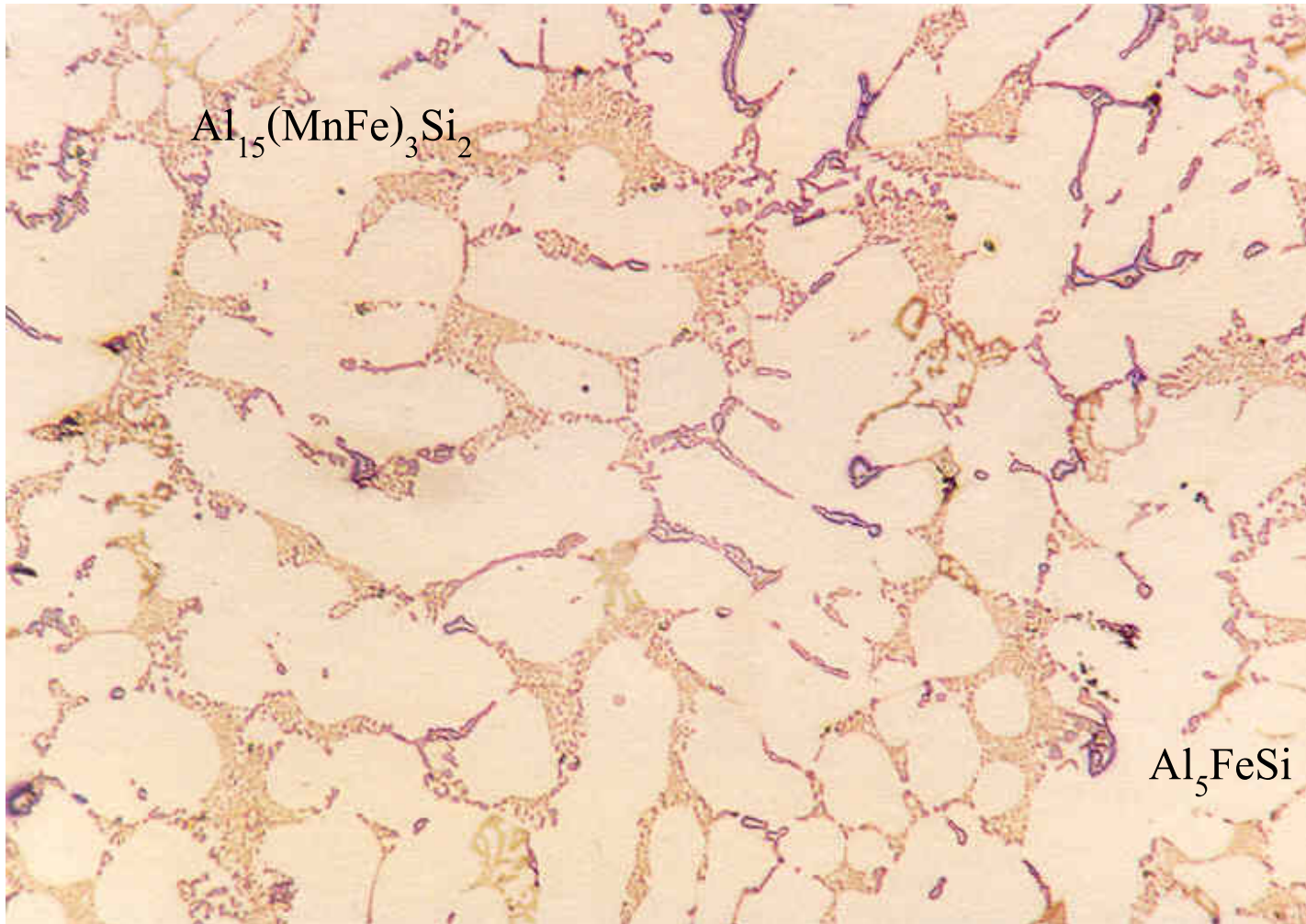
Cooling rate 0.3°C/s กำลังขยาย 110 เท่า



# Al alloy-319.1

Si=5.7,Fe=0.62,Cu=3.4,Mn=0.36,Mg=0.10,Zn=0.92,Ti=0.14

Cooling rate 5°C/s กำลังขยาย 110 เท่า



# Al alloy-319.1

Si=5.7,Fe=0.62,Cu=3.4,Mn=0.36,Mg=0.10,Zn=0.92,Ti=0.14

Cooling rate 5°C/s กำลังขยาย 110 เท่า

