

JC Casting Titanium Alloys Heat Treatment Procedure

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A Type or near α Type Alloys

Alloys	Heat Treatment	Heat Treatment Procedure
TA1 -TA3	Stress Relief Annealing	500-600°C 0.25-1h Air Cooling
TA1 -TA3	Recrystallization Annealing	680-720°C 0.5-2h Air Cooling
TA4 (Ti-3Al)	Stress Relief Annealing	500-600°C 0.25-1 h Air Cooling
TA4 (Ti-3Al)	Recrystallization Annealing	700 -750°C 0.5-2h Air Cooling
TA5 (Ti-4Al-0.005B)	Stress Relief Annealing	550-650°C 0.25-1h Air Cooling
TA5 (Ti-4Al-0.005B)	Recrystallization Annealing	800-850°C 0.5-2h Air Cooling
TA6 (Ti-5Al)	Stress Relief Annealing	550-650°C 0.25-2h Air Cooling
TA6 (Ti-5Al)	Recrystallization Annealing	750-800°C 0.5-2h Air Cooling
TA7 (Ti-5Al-2.5Sn)	Stress Relief Annealing	550-650°C 0.25-2h Air Cooling
TA7 (Ti-5Al-2.5Sn)	Recrystallization Annealing	750-800°C 0.5-2h Air Cooling
TA8 (Ti-5Al-2.5Sn- 1.5Zr-3Cu)	Stress Relief Annealing	550-650°C 0.25-2h Air Cooling
TA8 (Ti-5Al-2.5Sn-1.5Zr-3Cu)	Recrystallization Annealing	750-800°C 1-2h Air Cooling
Ti-811 (Ti-8Al-1Mo-1V)	Stress Relief Annealing	600-700°C 0.25-4h Air Cooling or Slow cooling
Ti-811 (Ti-8Al-1Mo-1V)	Recrystallization Annealing	760-790°C 1-8h Air Cooling or Furnace Cooling
Ti-811 (Ti-8Al-1Mo-1V)	Duplex Annealing	900-1010°C Air Cooling +600-745°C Air Cooling
Ti-811 (Ti-8Al-1Mo-1V)	Solid Solution Treatment	980-1010°C 1h Oil quenching or Water Cooling
Ti-811 (Ti-8Al-1Mo-1V)	Aging Treatment	565-595°C Air Cooling
Ti-6242S (Ti-6Al-2Sn-4Zr- 2Mo-0.088Si)	Stress Relief Annealing	480-700°C 0.25-4h Air Cooling or Slow Cooling

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Ti-6242S (Ti-6Al-2Sn-4Zr- 2Mo-0.088Si)	Recrystallization Annealing	700-840°C 1-8h Slow cooling to 560°C Air Cooling
Ti-6242S (Ti-6Al-2Sn-4Zr- 2Mo-0.088Si)	Duplex Annealing	900°C 0.5h Air Cooling+ 785°C 0.25h Air Cooling
Ti-6242S (Ti-6Al-2Sn-4Zr- 2Mo-0.088Si)	Triple Annealing	900°C . 2.5h Air Cooling+785°C 0.25h Air Cooling+595°C 2h Air Cooling
Ti-6242S (Ti-6Al-2Sn-4Zr- 2Mo-0.088Si)	Solid Solution Treatment	955-980°C 1h Water Cooling
Ti-6242S (Ti-6Al-2Sn-4Zr- 2Mo-0.088Si)	Aging Treatment	540-595°C 8h Air Cooling
Ti-6211 (Ti-6Al-2Nb-1Ta- 0.8Mo)	Stress Relief Annealing	595-650°C 0.25-2h Air Cooling
Ti-6211 (Ti-6Al-2Nb-1Ta- 0.8Mo)	Recrystallization Annealing	790-900°C 1-4h Air Cooling
Ti-6211 (Ti-6Al-2Nb-1Ta- 0.8Mo)	Solid Solution Treatment	1010°C 1h Water Cooling
Ti-6211 (Ti-6Al-2Nb-1Ta- 0.8Mo)	Aging Treatment	620°C 2h Air Cooling
IMI 679 (Ti-11Sn-5Zr-2.25 Al-1Mo-0.25Si)	Stress Relief Annealing	480-510°C 5-10h Air Cooling
IMI 679 (Ti-11Sn-5Zr-2.25 Al-1Mo-0.25Si)	Duplex Annealing	890°C 1h Air Cooling +500°C 24h Air Cooling
(Ti-11Sn-5Zr-2.25 Al-1Mo-0.25Si)	Solid Solution Treatment	900°C 1-2h Air Cooling or Oil quenching
IMI 679 (Ti-11Sn-5Zr-2.25 Al-1Mo-0.25Si)	Aging Treatment	490-510°C 24h Air Cooling

A+β Type Alloys

Alloys	Heat Treatment	Heat Treatment Procedure
TC1 (Ti-2Al-1.5Mn)	Stress Relief Annealing	550-650°C 0.5 -1h Air Cooling

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TC1 (Ti-2Al-1.5Mn)	Recrystallization Annealing	700-750°C 0.5-2h Air Cooling
TC2 (Ti-4Al-1.5Mn)	Stress Relief Annealing	550 - 650 °C 0.5 -1h Air Cooling
TC2 (Ti-4Al-1.5Mn)	Recrystallization Annealing	700-750°C 0.5-2h Air Cooling
TC3 (Ti-5Al-4V)	Stress Relief Annealing	550-650°C 0.5 -1h Air Cooling
TC3 (Ti-5Al-4V)	Recrystallization Annealing	700-800°C 1-2h Air Cooling
TC3 (Ti-5Al-4V)	Solid Solution Treatment	820-920°C 0.5-1h Water Cooling
TC3 (Ti-5Al-4V)	Aging Treatment	480-560°C 4-8h Air Cooling
TC4 (Ti-6Al-4V)	Stress Relief Annealing	480-650°C 1-4h Air Cooling
TC4 (Ti-6Al-4V)	Recrystallization Annealing	705-790°C 1-4h Air Cooling or Furnace Cooling
TC4 (Ti-6Al-4V)	Duplex Annealing	940°C 10min Air Cooling+ 675°C 4h Air Cooling
TC4 (Ti-6Al-4V)	β Annealing	1035°C 30min Air Cooling+ 730°C 2h Air Cooling
TC4 (Ti-6Al-4V)	β Solid Solution Aging Treatment	1035°C 30min Water Cooling + 510-675°C 4h Air Cooling
TC4 (Ti-6Al-4V)	Solid Solution Aging Treatment	940°C 10min Water Cooling + 510-540°C 4h Air Cooling
TC4 (Ti-6Al-4V)	Solid Solution Aging Treatment	940°C 10min Water Cooling + 675°C 4h Air Cooling
TC6 (Ti-6Al-2.5 Mo- 1.5Cr-0.5Fe-0.3Si)	Stress Relief Annealing	550-650°C 0.5-2h Air Cooling
TC6 (Ti-6Al-2.5 Mo- 1.5Cr-0.5Fe-0.3Si)	Recrystallization Annealing	750-850°C 1-2h Air Cooling
TC6 (Ti-6Al-2.5 Mo- 1.5Cr-0.5Fe-0.3Si)	Duplex Annealing	870-920°C 1h Air Cooling + 550-650°C . 2-5h
TC6 (Ti-6Al-2.5 Mo- 1.5Cr-0.5Fe-0.3Si)	Solid Solution Treatment	860-900°C 0.5-1h Water Cooling
TC6 (Ti-6Al-2.5 Mo- 1.5Cr-0.5Fe-0.3Si)	Solid Solution Aging Treatment	540-580°C 4-12h Air Cooling
TC8 (Ti-6.5Al-3.5Mo-0.25Si)	Stress Relief Annealing	550-650°C 0.5-4h Air Cooling

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TC8 (Ti-6.5Al-3.5Mo-0.25Si)	Duplex Annealing	920°C 1-4h Air Cooling+ 590°C 1h Air Cooling
TC8 (Ti-6.5Al-3.5Mo-0.25Si)	Solid Solution Treatment	900-950°C 1-1.5h Water Cooling
TC8 (Ti-6.5Al-3.5Mo-0.25Si)	Aging Treatment	500-600°C 2-6h Air Cooling
TC9 (Ti-6.5Al-3.5Mo-2.5Sn-O. 3Si)	Stress Relief Annealing	550-650°C 0.5-4h Air Cooling
TC9 (Ti-6.5Al-3.5Mo-2.5Sn-O. 3Si)	Duplex Annealing	950°C 1-2h Air Cooling + 530°C 6h Air Cooling
TC9 (Ti-6.5Al-3.5Mo-2.5Sn-O. 3Si)	Solid Solution Treatment	900-950°C 1-1.5h Water Cooling
TC9 (Ti-6.5Al-3.5Mo-2.5Sn-O. 3Si)	Aging Treatment	500-600°C 2-6h Air Cooling
TC10 (Ti-6Al-6V-2Sn-0.5Cu-0.5Fe)	Stress Relief Annealing	550-650°C 0.5-4h Air Cooling
TC10 (Ti-6Al-6V-2Sn-0.5Cu-0.5Fe)	Recrystallization Annealing	700-800°C 1h Air Cooling
TC10 (Ti-6Al-6V-2Sn-0.5Cu-0.5Fe)	Solid Solution Treatment	850-900°C 1-1.5h Water Cooling
TC10 (Ti-6Al-6V-2Sn-0.5Cu-0.5Fe)	Aging Treatment	500-600°C . 4-12h Air Cooling
TC11 (Ti-6.5Al-3.5Mo-1.5 Zr-0.3Si)	Stress Relief Annealing	550-650°C .Air Cooling
TC11 (Ti-6.5Al-3.5Mo-1.5 Zr-0.3Si)	Duplex Annealing	950°C 1-2h Air Cooling+ 530°C 6h Air Cooling
TC11 (Ti-6.5Al-3.5Mo-1.5 Zr-0.3Si)	Solid Solution Treatment	900-950°C 1-1.5h Water Cooling
TC11 (Ti-6.5Al-3.5Mo-1.5 Zr-0.3Si)	Aging Treatment	500-600°C 2-6h Air Cooling
Ti-6Al-6V-2Sn	Stress Relief Annealing	480-650°C 1-4h Air Cooling or Slow cooling
Ti-6Al-6V-2Sn	Recrystallization Annealing	700-750°C 2-8h Air Cooling or Slow cooling
Ti-6Al-6V-2Sn	Solid Solution Treatment	870-900°C 1h Water Cooling
Ti-6Al-6V-2Sn	Aging Treatment	540-620°C f 4-8h Air Cooling
Ti -17 (Ti-5Al-2Sn-2Zr-4Mo-4Cr)	Stress Relief Annealing	480-650°C 1-4h Air Cooling or Slow cooling

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Ti -17 (Ti-5Al-2Sn-2Zr-4Mo-4Cr)	Duplex Solid Solution Aging Treatment ($\alpha+\beta$ Forging)	815-860°C 4h Air Cooling + 800°C 4h Water Cooling+620-650°C 8h Air Cooling
Ti -17 (Ti-5Al-2Sn-2Zr-4Mo-4Cr)	Solid Solution Aging (β Forging)	860°C 4h Water Cooling + 620-650°C 8h Air Cooling
Ti-6246(Ti-6Al-2Sn-4Zr- 6Mo)	Stress Relief Annealing	595-705°C 0.25-4h Air Cooling or Slow cooling
Ti-6246(Ti-6Al-2Sn-4Zr- 6Mo)	Solid Solution Annealing	815 -925°C Air Cooling
Ti-6246(Ti-6Al-2Sn-4Zr- 6Mo)	Duplex Annealing	815 -925°C Air Cooling+540-730°C Air Cooling
Ti-6246(Ti-6Al-2Sn-4Zr- 6Mo)	Triple Annealing	815 -925°C Air Cooling+540- 730°C Air Cooling+ 540-730°C Air Cooling (The first aging temperature is high)
Ti-6246(Ti-6Al-2Sn-4Zr- 6Mo)	Solid Solution Treatment	815 -925°C 1h Oil quenching or Water quenching
Ti-6246(Ti-6Al-2Sn-4Zr- 6Mo)	Aging Treatment	580-605°C 4-8h Water Cooling
Ti-6-22-22S(Ti-6Al-2Sn-2Zr- 2Mo-2Cr-0.2Si)	Recrystallization Annealing	730°C 2h Air Cooling
Ti-6-22-22S(Ti-6Al-2Sn-2Zr- 2Mo-2Cr-0.2Si)	Solid Solution Treatment	β_T -28°C 30min Air Cooling
Ti-6-22-22S(Ti-6Al-2Sn-2Zr- 2Mo-2Cr-0.2Si)	Aging Treatment	480-540°C 8h Air Cooling

β Type Alloys

Alloys	Heat Treatment	Heat Treatment Procedure
TB1 (Ti-3Al-8Mo-11Cr)	Solid Solution Treatment	800°C 30min Air Cooling or Water Cooling
TB1 (Ti-3Al-8Mo-11Cr)	Aging Treatment	450-560°C 0.25-24h Air Cooling

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TB2 (Ti-3Al-5Mo-5V -8Cr)	Stress Relief Annealing	480-650°C 0.25-4h Air Cooling
TB2 (Ti-3Al-5Mo-5V -8Cr)	Recrystallization Annealing	800°C 30min Air Cooling
TB2 (Ti-3Al-5Mo-5V -8Cr)	Solid Solution Treatment	800°C 30min Air Cooling or Water Cooling
TB2 (Ti-3Al-5Mo-5V -8Cr)	Aging Treatment	500°C 8h Air Cooling
(Ti-13V-11Cr-3Al)	Stress Relief Annealing	700-785°C 5-15min Air Cooling
(Ti-13V-11Cr-3Al)	Recrystallization Annealing	700-1040°C 0.25-1h Air Cooling
(Ti-13V-11Cr-3Al)	Solid Solution Treatment	700-1040°C 0.25-1h Air Cooling or Water Cooling
(Ti-13V-11Cr-3Al)	Aging Treatment	425-510°C 20-100h Air Cooling
Ti-10-2-3(Ti-10V-2Fe-3Al)	Stress Relief Annealing	657-700°C 0.5-2h Air Cooling or Slow cooling
Ti-10-2-3(Ti-10V-2Fe-3Al)	Recrystallization Annealing	730-775°C 1h Water Cooling
Ti-10-2-3(Ti-10V-2Fe-3Al)	Solid Solution Treatment	480-620°C 8h Air Cooling
Ti-10-2-3(Ti-10V-2Fe-3Al)	Aging Treatment	580-595°C 8h Air Cooling
βIII (Ti-11.5Mo-6Zr-4.5Sn)	Stress Relief Annealing	700-730°C 5-15min Air Cooling or Slow cooling
βIII (Ti-11.5Mo-6Zr-4.5Sn)	Recrystallization Annealing	690-760°C 10min-1h Air Cooling or Water Cooling
βIII (Ti-11.5Mo-6Zr-4.5Sn)	Solid Solution Treatment	690-790°C 1h Air Cooling or Water Cooling
βIII (Ti-11.5Mo-6Zr-4.5Sn)	Aging Treatment	480-595°C 8-32h Air Cooling
βC(Ti-3Al-8V-6Cr-4Zr-4Mo)	Stress Relief Annealing	705-760°C 10-30min Air Cooling or Slow cooling
βC(Ti-3Al-8V-6Cr-4Zr-4Mo)	Recrystallization Annealing	790-815°C 0.25-1h Air Cooling or Water Cooling
βC(Ti-3Al-8V-6Cr-4Zr-4Mo)	Solid Solution Treatment	815-925°C 1h Water Cooling
βC(Ti-3Al-8V-6Cr-4Zr-4Mo)	Aging Treatment	455-540°C 8-24h Air Cooling
Ti-15-3 (Ti-15V-3Al-3Cr-3Sn)	Stress Relief Annealing	790-815°C 5-25min Air Cooling or Slow cooling
Ti-15-3 (Ti-15V-3Al-3Cr-3Sn)	Recrystallization Annealing	790-815°C 5-25min Air Cooling
Ti-15-3 (Ti-15V-3Al-3Cr-3Sn)	Solid Solution Treatment	790-815°C 0.25h Air Cooling



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Ti-15-3 (Ti-15V-3Al-3Cr-3Sn)	Aging Treatment	510-595 °C 8-24h Air Cooling
β21S(Ti-15Mo-3Al-2.7Nb-0.25Si)	Solid Solution Treatment	800-815 °C > 4min
β21S(Ti-15Mo-3Al-2.7Nb-0.25Si)	Aging Treatment	480-595 °C 8-24h Air Cooling
β21S(Ti-15Mo-3Al-2.7Nb-0.25Si)	Duplex Aging Treatment	690 °C 8h Air Cooling + 650 °C 8h Air Cooling