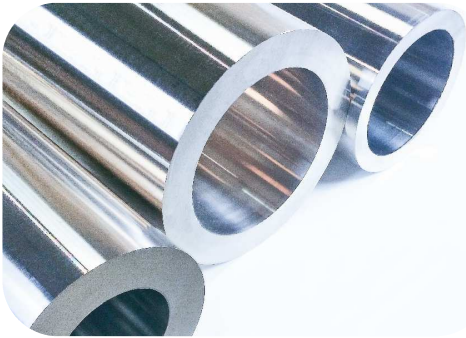


HARDIALL®

High Strength Spinodal Copper Nickel Tin Alloys



Mining Applications



Hardiall® is a wrought spinodally hardened copper alloy **CuNi15Sn8 (C72900)** designed for high strength applications where toughness is required. It is non-magnetic and resists mechanical wear, galling, stress relaxation, corrosion and erosion.

It is easily machined into complex components whilst being **environmentally friendly being both lead and beryllium free.**

Hardiall® is used within the mining industry thanks to its **outstanding physical and mechanical properties in many varied components.** Lebronze alloys has developed a full range of Hardiall® products matching the stringent needs of the Mining industry.

Hardiall® Properties and Benefits

Hardiall® Key Features & Benefits

- High strength & hardness
- Low friction
- Excellent lubricity
- Corrosion & Erosion resistant
- Excellent wear resistance
- Excellent machinability
- Excellent galling resistance
- Pitting & spalling resistance
- No Hydrogen embrittlement
- Non-magnetic
- High performance at both elevated and sub-zero temperatures -193 °F up to 572 °F
- Dimensional stability

Lebronze Alloys manufacturing process for Hardiall® is fully integrated: internal processes include casting, hot and cold working stage, heat treatment and non-destructive testing. Being fully integrated ensures reactivity and complete traceability.

Hardiall® Physical Properties

Hardiall® Physical Properties		
Electrical Conductivity at 20 °C (68 °F)	7.5	% IACS
Thermal Conductivity at 20 °C to 200°C (68 °F to 392 °F)	38 (22)	W/m/°C (Btu/ft/hr/°F)
Coefficient of Thermal Expansion at 20 °C to 200 °C (68 °F to 392 °F)	16,4x10 ⁻⁶ (9.1x10 ⁻⁶)	Per °C (Per °F)
Density	8.95 (0.323)	g/cm ³ (lb/in ³)

Hardiall® Key Applications in Mining



Bushings and Bearings

In mining equipment, bushings and bearings are highly solicited components. They need to be lubricated and replaced frequently implying recurrent production downtimes and maintenance man hours.

Hardiall® is used in excavators, mining trucks and longwall shearers. For such mining vehicles, Hardiall® demonstrates excellent **lubricity, wear and galling** resistance making it the **ideal material for bushings and bearings.**

For these applications, Hardiall® outperforms steel and manganese bronze by **increasing the durability, the reliability** and the **lubrication cycles** of highly solicited bushings and bearings..

Hardiall® Products Portfolio

Hardiall® is available in various tempers and grades differing from their mechanical properties. The following table indicates Hardiall® products available for the Mining industry.

Mechanical Properties of Hardiall® Alloys*							
LBA Designation	Minimal Yield Strength 0.2% offset (MPa [ksi])	Minimal Elongation 4D (%)	Typical Hardness (HRC)	Minimal UTS (Mpa [ksi])	Available forms	Available sizes	
Wrought and spinodally hardened Hardiall® rods							
Hardiall TX 90	620 [90]	15	26				
Hardiall TX 105	724 [105]	4	30	Contact us for more properties, customized products, size information, and stock availabilities: contact-hardiall@lebronze-alloys.com			
	652 [94.5]	4	30				
Hardiall TX 110	760 [110]	10	30				
	760 [110]	6	30				
Solution annealed, cold finished and spinodally hardened Hardiall® rods							
Hardiall TS 95	655 [95]	18	93 HRB		Contact us for more properties, customized products, size information, and stock availabilities: contact-hardiall@lebronze-alloys.com		
	655 [95]	18	93 HRB				
Hardiall TS 120U	755 [110]	15	24				
	755 [110]	15	22				
Hardiall TS 130	895 [130]	10	24				
Hardiall TS 160U	1035 [150]	3	34				
	1020 [148]	3	32				
Wrought and spinodally hardened Hardiall® hollow bars/tubes (length limited to 1,000 mm)							
Wall thickness: 10 to 20 % of Ø							
Hardiall TX 105	724 [105]	4	30	Contact us for more properties, customized products, size information, and stock availabilities: contact-hardiall@lebronze-alloys.com			
	652 [94.5]	4	30				
Hardiall TX 110	760 [110]	10	30				
	760 [110]	6	30				
	760 [110]	5	30				

*Measurements made in laboratory conditions. Non contractual.
TS 120U & TS 160U refer to UTS, other tempers refer to YS

All products can be ultrasonic tested at LBA upon customer request.
Corrosion resistance according to NACE MR0175/ ISO 15156

Lebronze alloys was born from the integration of companies specialized in the production of copper alloys, copper, nickel alloys, aluminum, special steel, stainless steel, titanium and super alloys.

Thanks to its multidisciplinary know-how, the Group provides innovative solutions to all major industries such as Aerospace, Oil & Gas, Energy, Off-highway Mining and Railways, but is also present in sectors that manufacture personal equipment.

Our 14 production sites and 1,300 employees master a unique range of metal processing technologies: continuous and semi-continuous casting, sand casting, chill casting (manual, mechanized, robotic), centrifugal casting, extrusion, ring rolling, hot and cold rolling, drawing, free forging, forging, die stamping, stamping, heat treatment, cold stamping, machining, non-destructive tests, etc.

Offering a solution that is suited and optimized to the needs of each industry is our Group's commitment.



Do you want to know more, discuss a project with us or make a request for quotation?

Contact: contact-hardiall@lebronze-alloys.com

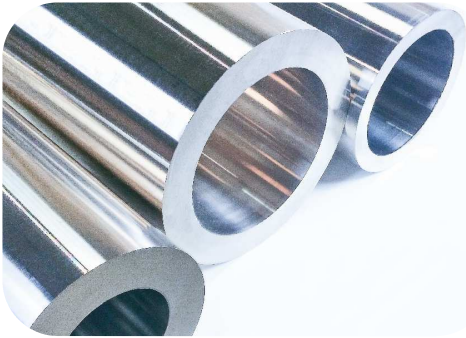
Web site: www.lebronze-alloys.com

HARDIALL®

High Strength Spinodal Copper Nickel Tin Alloys

lba
lebronze alloys

Oil & Gas Applications



Hardiall® is a wrought spinodally hardened copper alloy **CuNi15Sn8 (C72900)** designed for high strength applications where toughness is required. It is non-magnetic and resists mechanical wear, galling, stress relaxation, corrosion and erosion.

It is easily machined into complex components whilst being **environmentally friendly being both lead and beryllium free**.

Hardiall® is used within the oil & gas industry thanks to its **outstanding physical and mechanical properties in many varied components**. Lebronze alloys has developed a full range of Hardiall® products matching the stringent needs of the oil & gas industry

Hardiall® Properties and Benefits

Hardiall® Key Features & Benefits

- High strength & hardness
- Low friction
- Excellent lubricity
- Corrosion & Erosion resistant
- Excellent wear resistance
- Excellent machinability
- Excellent galling resistance
- Pitting & spalling resistance
- No Hydrogen embrittlement
- Non-magnetic
- High performance at both elevated and sub-zero temperatures -193 °F up to 572 °F
- Dimensional stability

Lebronze Alloys manufacturing process for Hardiall® is fully integrated: internal processes include casting, hot and cold working stage, heat treatment and non-destructive testing. Being fully integrated ensures reactivity and complete traceability.

Hardiall® Physical Properties

Electrical Conductivity at 20 °C (68 °F)	7.5	% IACS
Thermal Conductivity at 20 °C to 200°C (68 °F to 392 °F)	38 (22)	W/m/°C (Btu/ft/hr/°F)
Coefficient of Thermal Expansion at 20 °C to 200 °C (68 °F to 392 °F)	16.4x10 ⁻⁶ (9.1x10 ⁻⁶)	Per °C (Per °F)
Density	8.95 (0.323)	g/cm ³ (lb/in ³)

Hardiall® Key Applications in Oil & Gas



Bushings and Bearings

Hardiall® is used in bushings and bearings for drilling components. For such applications, Hardiall® demonstrates outstanding **wear, corrosion, temperature and pressure resistance**. Thus providing a **longer service life** and a **better total cost of ownership (TCO)** compared to Beryllium Copper but also some Nickel or Cobalt based alloys.

Hardiall® can be used in both offshore and onshore systems and in vertical or directional drilling products.

Couplings for onshore production systems

Hardiall is also used in onshore oil pumps as sucker rod and valve rod guide bushing couplings. In such applications where stainless steel is generally used, Hardiall® demonstrates **excellent resistance to metal-to-metal wear**. Thus providing a reduction of **failures** and hence **maintenance downtimes**.

For these applications Lebronze alloys integrated supply chain is able to propose ready-to-use products.



Hardiall® Products Portfolio

Hardiall® is available in various tempers and grades differing from their mechanical properties. The following table indicates Hardiall® products available for the Oil and Gas industry.

Mechanical Properties of Hardiall® Alloys*						
LBA Designation	Minimal Yield Strength 0.2% offset (MPa [ksi])	Minimal Elongation 4D (%)	Typical Hardness (HRC)	Minimal UTS (Mpa [ksi])	Available forms	Available sizes
Wrought and spinodally hardened Hardiall® rods						
Hardiall TX 90	620 [90]	15	26			
Hardiall TX 105	724 [105]	4	30	Contact us for more properties, customized products, size information, and stock availabilities: contact-hardiall@lebronze-alloys.com		
	652 [94.5]	4	30			
Hardiall TX 110	760 [110]	10	30			
	760 [110]	6	30			
Solution annealed, cold finished and spinodally hardened Hardiall® rods						
Hardiall TS 95	655 [95]	18	93 HRB	Contact us for more properties, customized products, size information, and stock availabilities: contact-hardiall@lebronze-alloys.com		
	655 [95]	18	93 HRB			
Hardiall TS 120U	755 [110]	15	24			
	755 [110]	15	22			
Hardiall TS 130	895 [130]	10	24			
Hardiall TS 160U	1035 [150]	3	34			
	1020 [148]	3	32			
Wrought and spinodally hardened Hardiall® hollow bars/tubes (length limited to 1,000 mm)						
Wall thickness: 10 to 20 % of Ø						
Hardiall TX 105	724 [105]	4	30	Contact us for more properties, customized products, size information, and stock availabilities: contact-hardiall@lebronze-alloys.com		
	652 [94.5]	4	30			
Hardiall TX 110	760 [110]	10	30			
	760 [110]	6	30			
	760 [110]	5	30			

*Measurements made in laboratory conditions. Non contractual.
TS 120U & TS 160U refer to UTS, other tempers refer to YS

All products can be ultrasonic tested at LBA upon customer request.
Corrosion resistance according to NACE MR0175/ ISO 15156

Lebronze alloys was born from the integration of companies specialized in the production of copper alloys, copper, nickel alloys, aluminum, special steel, stainless steel, titanium and super alloys.

Thanks to its multidisciplinary know-how, the Group provides innovative solutions to all major industries such as Aerospace, Oil & Gas, Energy, Off-highway Mining and Railways, but is also present in sectors that manufacture personal equipment.

Our 14 production sites and 1,300 employees master a unique range of metal processing technologies: continuous and semi-continuous casting, sand casting, chill casting (manual, mechanized, robotic), centrifugal casting, extrusion, ring rolling, hot and cold rolling, drawing, free forging, forging, die stamping, stamping, heat treatment, cold stamping, machining, non-destructive tests, etc.

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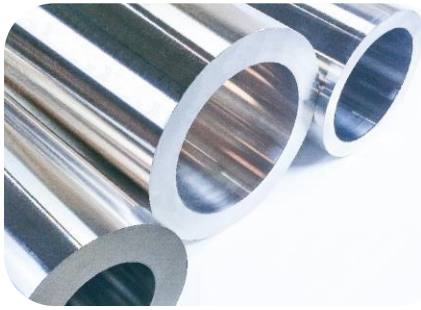
HARDIALL®

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Copper Nickel Tin Alloys



lebronze alloys

Aerospace Applications



Hardiall® is a wrought spinodally hardened copper alloy **CuNi15Sn8 (C72900)** designed for high strength applications where toughness is required. It is non-magnetic and resists mechanical wear, galling, stress relaxation, corrosion and erosion.

It is easily machined into complex components whilst being **environmentally friendly being both lead and beryllium free.**

Hardiall® is used within the aerospace industry thanks to its **outstanding physical and mechanical properties in many different components.** Lebronze alloys has developed a full range of Hardiall® products matching the stringent needs of the Aerospace industry.

Hardiall® Properties and Benefits

Hardiall® Key Features & Benefits

- High strength & hardness
- Low friction
- Excellent lubricity
- Corrosion & Erosion resistant
- Excellent wear resistance
- Excellent machinability
- Non-sparking
- Excellent galling resistance
- Pitting & spalling resistance
- No Hydrogen embrittlement
- Non-magnetic
- High performance at both elevated and sub-zero temperatures -193 °F up to 572 °F
- Dimensional stability

Lebronze Alloys manufacturing process for Hardiall® is fully integrated: internal processes include casting, hot and cold working stage, heat treatment and non-destructive testing. Being fully integrated ensures reactivity and complete traceability.

Hardiall® Physical Properties

Electrical Conductivity at 20 °C (68 °F)	7,5	% IACS
Thermal Conductivity at 20 °C to 200°C (68 °F to 392 °F)	38 (22)	W/m°C (Btu/ft/hr°F)
Coefficient of Thermal Expansion at 20 °C to 200 °C (68 °F to 392 °F)	16,4x10 ⁻⁶ (9,1x10 ⁻⁶)	Per °C (Per °F)
Density	8,95 (0,323)	g/cm ³ (lb/in ³)

Hardiall® Key Applications in Aerospace



Bushings and Bearings in actuation systems for landing gears, primary and secondary flight controls, attachments

Hardiall is a very good bearing and bushing material due to its high strength, low magnetic sensitivity, excellent machinability, maximum corrosion resistance and thus high surface resistance under impact loads and especially in critical lubrication conditions.

Compared to conventional bearing materials it provides longer lifespan, higher reliability and better construction flexibility.

In landing gears, bushings and bearings are required to operate under severe conditions, they need to be lubricated and replaced frequently causing recurring maintenance downtimes.

Thus providing a **longer service life** and an improved **total cost of ownership (TCO)** compared to other copper and non-copper alloys materials.

Hardiall® is ideal for applications where the load required exceeds the **performance of copper-nickel-aluminum based alloys** or where **lubricity is critical, and titanium cannot satisfy the Engineers requirements.**

Hardiall® Products Portfolio

Hardiall® is available in various tempers and grades differing from their mechanical properties. The following table indicates Hardiall® products available for the Aerospace industry.

Mechanical Properties of Hardiall® Alloys*						
LBA Designation / Norm	Minimal Yield Strength 0.2% offset (MPa)	Minimal UTS (MPa)	Minimal Elongation 4D (%)	Typical Hardness (HRC)	Available forms	Available sizes
Wrought and spinodally hardened Hardiall® rods						
Hardiall TX 90	620	760	15	26	Rods	60 ≤ Ø < 101,6 mm
AMS 4596	738	910	9,5	30	Rods	19 ≤ Ø < 108 mm
	745	876	3	30	Rods	Ø ≥ 108 mm
Hardiall TX 110	760	910	10	30	Rods	19 ≤ Ø < 101,6 mm
	760	875	6	30	Rods	Ø ≥ 101,6 mm
Wrought hot worked, cold finished and spinodally hardened Hardiall® rods						
Hardiall TS 160U	1035	1105	3	34	Rods	40 ≤ Ø < 82 mm
	1020	1100	3	32	Rods	82 ≤ Ø < 90 mm
AMS 4597	1069	1137	6	35	Rods	19 ≤ Ø < 40 mm
	1020	1075	3	34	Rods	40 ≤ Ø < 90 mm
Wrought and spinodally hardened Hardiall® hollow bars/tubes (length max 1 m) Wall thickness: 10 to 20 % of Ø						
AMS 4598	717	903	8	30	Tubes	60 ≤ Ø < 184 mm
	745	896	5	30	Tubes	Ø ≥ 184 mm
Hardiall TX 110	760	895	10	30	Tubes	60 ≤ Ø < 101,6
	760	895	6	30	Tubes	101,6 ≤ Ø < 203 mm
	760	895	5	30	Tubes	Ø ≥ 203 mm

**Measurements made in laboratory conditions. Non contractual.
TS 160U refers to the UTS, other tempers refer to YS.*

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