

GRCop-42 Copper

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Material & Process Capability

GRCop-42 is a copper-chromium-niobium alloy. The alloy was developed by NASA to additively manufacture parts in need of high-strength dispersion and high conductivity. It retains strength at high temperature, due to the use of chromium and niobium in the alloy. Velo3D has developed processes that maintain high density in the printed part. GRCop-42 also has excellent creep resistance, and a low cycle fatigue life.

All of these properties are particularly valuable for rocket engine components such as fuel injector faces and combustion chamber linings with regenerative cooling.

General Process

Velo3D has successfully printed dense components with GRCop-42 using its fully integrated additive manufacturing process. This data sheet specifies the expected mechanical properties and characteristics of this alloy when manufactured on a Velo3D Sapphire System. All data is based on parts built using Velo3D standard 50 μm layer thickness parameters, using Praxair TruForm™ CU42-N30, CU42-P55, Carpenter CT-GRCop42-AAAA and KBM GRCU42015063ROC, all Velo3D-approved powders. Parts built from GRCop-42 on a Sapphire System can be heat treated like those manufactured by other methods.

Powders: Praxair TruForm CU42-N30 and TruForm CU42-P55



Density, g/cc (lbs/cubic in)	8.79 (0.318)
Relative Density, percent	99+
Surface Finish ¹ , S _a , μm (μin)	<35 (1378)

Mechanical Properties² at Room Temperature

				After HIP ⁴					
				Ultimate Tensile Strength, MPa (ksi)		Yield (0.2% Offset), MPa (ksi)		Elongation At Break, percent	
Powder	Process Recipe	TBR (cc/h) ³	Sample Size	Mean-3 σ	Mean	Mean-3 σ	Mean	Mean-3 σ	Mean
Praxair TruForm CU42-N30	1kW/50 μm	32	148	378 (55)	389 (56)	187 (27)	192 (28)	28.9	33.3
Praxair TruForm CU42-P55			366	383 (56)	391 (57)	185 (27)	194 (28)	29.4	33.4

Thermal Conductivity after HIP⁴

				Thermal Conductivity W/mK	
Powder	Sample Size	Temperature	Mean		
Praxair TruForm CU42-N30	6	25°C	323		
		260°C	317		
		537.8°C	303		

1. Depends on orientation and process selected; for angles >25° from horizontal. **2.** Mechanical & test samples printed in vertical orientation, machined to ASTM E8 (round specimen #3). **3.** TBR: Theoretical Build Rate (TBR) is a per-laser build rate calculated from the process conditions of bulk core as $\text{scan speed} \times \text{hatch spacing} \times \text{layer thickness}$. This value represents a single laser only and is reported for comparison purposes across different materials and recipes, but does not correspond to true build rate, which is dependent on geometry and system characteristics (i.e. number of lasers, recoat times, etc.) **4.** HIP conditions: 1750 \pm 25 °F, 15 \pm 0.5 ksi; 3 hours (+15/-0 min) in inert environment.

Powders: Carpenter CT-GRCop42-AAAA and KBM GRCU42015063ROC



Density, g/cc (lbs/cubic in)	8.79 (0.318)
Relative Density, percent	99+
Surface Finish ¹ , S _a , μm (μin)	<35 (1378)

Mechanical Properties² at Room Temperature

				After HIP ⁴		
				Ultimate Tensile Strength, MPa (ksi)	Yield (0.2% Offset), MPa (ksi)	Elongation At Break, percent
Powder	Process Recipe	TBR (cc/h) ³	Sample Size	Mean	Mean	Mean
Carpenter CT-GRCop42-AAAA	1kW/50 μm	29	43	365 (53)	176 (26)	36.6
KBM GRCU42015063ROC			22	364 (53)	181 (26)	35.6

Thermal Conductivity after HIP⁴

Thermal Conductivity W/mK			
Powder	Sample Size	Temperature	Mean
Carpenter CT-GRCop42-AAAA	2	25°C	347
		260°C	322
		537.8°C	306
KBM GRCU42015063ROC	3	25°C	351
		260°C	327
		540°C	321

1. Depends on orientation and process selected; for angles >25° from horizontal. **2.** Mechanical & test samples printed in vertical orientation, machined to ASTM E8 (round specimen #3). **3.** TBR: Theoretical Build Rate (TBR) is a per-laser build rate calculated from the process conditions of bulk core as *scan speed x hatch spacing x layer thickness*. This value represents a single laser only and is reported for comparison purposes across different materials and recipes, but does not correspond to true build rate, which is dependent on geometry and system characteristics (i.e. number of lasers, recoat times, etc.) **4.** HIP conditions: 1750 ± 25 °F, 15 ± 0.5 ksi; 3 hours (+15/-0 min) in inert environment.