# 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 Properties[2] 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-3σ | Mean | Mean-3σ | Mean | Mean-3σ | 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 HIP[4]

| | | 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 *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.

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## Powders: Carpenter CT-GRCop42-AAAA and KBM GRCU42015063ROC

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### Mechanical Properties[2] 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 HIP[4]

| | | 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 |

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