GRCop-42 Alloy Gas Atomized Powder Specification

1. The GRCop-42 powder shall be produced using vacuum or inert induction melting and gas atomization in argon. Atomization in nitrogen is not an acceptable alternative.

2. The furnace charge for atomization shall consist of master alloys, virgin melt stock or any combination thereof.

3. Unless explicitly specified by the purchase request, the requested quantity of powder shall be supplied as a single lot. The single lot may be a blend of multiple, smaller heat lots. Blending of multiple heat lots into a single lot shall be allowed only if every heat lot blended is verified independently to meet all aspects of this specification. Heat lot numbers and their independent certification shall be provided for each blended lot. Blending of heat lots shall not be used to control chemistry or particle size distribution. Blending of heat lots shall not occur other than at the original powder producer.

4. The GRCop-42 powder shall have composition as shown in Table 1.

Table 1. GRCop-42 Powder Composition (weight%)

Element	Minimum	Maximum	Target
Cr	3.1	3.40	3.27
Nb	2.7	3.00	2.92
Fe	—	250 PPM	Target <50 ppm
O	—	500 PPM	Target <250 ppm
Al	—	600 PPM	Target <400 ppm
Si	—	350 PPM	Target <100 ppm
Cu		Balance	
Cr/Nb*	2.02 (atomic) 1.13 (weight)	2.12 (atomic) 1.18 (weight)	2.07 (Atomic) 1.14 (weight)

* Atomic ratio is based on percentage of Cr and Nb in atomic percent. Weight ratio is based on percentage of Cr and Nb in weight percent.

5. Chemical composition shall be verified for carbon, sulfur, nitrogen, and oxygen per ASTM E1019 with only O controlled but all four elements reported. Other elements of Table 1 shall be verified by wet chemical methods per ASTM E354 or inductively coupled plasma spectroscopy per ASTM E2594. Other methods with equivalent sensitivities and accuracies may be used if agreed upon prior to contract award. Chemical check analysis limits of SAE AMS 2269 shall be applicable.

6. The contractor shall test for Fe and O contamination and proper Cr:Nb ratios prior to mixing powder from more than one atomization run. Powders from multiple heat lots shall be mixed as best possible in an inert atmosphere prior to packaging for shipping to provide better uniformity.

7. The GRCop-42 powder particle size distribution (PSD) shall target the ranges listed in Table 3. The supplier shall furnish a certification for each powder lot per ASTM B214 (Sieve Analysis) and ASTM B822 (Light Scattering) including analysis for the mesh size, name of analyzing lab, the date analyzed, and analysis method. A standard PSD plot of frequency versus powder size, D_{10}, D_{50} and D_{90} values on a volume basis shall be provided as well. Other methods may be used if agreed upon prior to contract award.

Table 2, GRCop-42 Powder Composition (weight %)

Powder	**Mesh or Micron Size**	**Notes**
GRCop-42-AM1	-140 mesh/+325 mesh 105 (um)/45 (um)	1. Particles greater than +140 mesh shall be limited to ≤ 1.0 weight % per ASTM B214 2. Particles smaller than +325 mesh shall be limited to < 5.0 weight % per ASTM B214
GRCop-42-AM2	-325 mesh/+1250 mesh -45 (um)/+10 (um)	1. Particles greater than +325 mesh shall be limited to ≤ 5.0 weight % per ASTM B214 2. Particles greater than +270 mesh shall be limited to ≤ 0.0 weight % per ASTM B214 3. Particles smaller than 10 (um) shall be limited to ≤ 5.0 cumulative volume % per ASTM B822

8. GRCop-42 powder shall be spherical in shape, free of significant satellite particles, and have smooth surfaces other than the normal dendritic structure. The powder vendor shall demonstrate that they have met these requirements by supplying images of a mono-layer sample of the powder lot of approximately 0.5 cm2 area at sufficient magnification/resolution to observe particle shape and confirm the absence of significant satellite particles. Powder sampling must meet minimum acceptable methods as defined in ASTM B215.

9. Post-production additions to the powder lot for control of PSD or chemistry shall not be allowed.

10. The GRCop-42 powder shall be handled and processed under inert atmosphere or vacuum environment at all times to avoid oxygen contamination. All exposures to atmosphere during

handling and processing will be described prior to processing and shall only be allowed with pre-approval by NASA.

11. GRCop-42 powder shall be shipped in double sealed aluminum cans or other air-tight containers under an argon, helium or nitrogen cover gas. Each container shall be no larger than 20 kg. Plastic bags may not be used for the storage and shipping of the powder.

12. All containers shall be clearly marked with, at a minimum, the manufacturer, the alloy (GRCop-42) and the lot number. Additional information such as the date manufacture, fire-health-reactivity-specific hazards, etc., is permitted and encouraged for completeness.

13. The GRCop-42 powder shall be delivered with Certificates of Conformance (CoC) specifying lot number, and the date and facility location of powder production, and verification of compliance to all requirements listed in this specification. If the provided lot of powder is a blend of heat lots, the CoC must contain compliance information for each heat lot as well as the blended powder.

Deliverables

1. Vendor shall supply a minimum **500 Kgs of GRCop-42 (-45 (um)/+10 (um))** according to requirements for Table 1 and per GRCop-42-AM2 as described in Table 2 including all CoC information.