

SPECIFICATION			
Document Owner MATERIALS ENGINEERING	Release Date 08/11/2025	Procedure Number MP-SP-001	Revision C
Title POWDER, NIOBIUM-HAFNIUM (C103)			

REVISION	RELEASE DATE	NATURE OF CHANGES
A	08/08/2022	N/A INITIAL RELEASE
B	01/09/2024	Previously numbered CMS-009. Rewritten to include Class 2 powder definition. Added definition around virgin and reused requirements. Clarified Responsibility for Inspection (5.1)
C	8/11/2025	Added new approved methods for determining chemistry of powder, removed requirement for visual inspection of monolayer of powder, removed specifications from applicable documents that are not referenced in the body of the specification. Changed PSD requirements to align with AMS 7025. Clarified requirements. Reformatted to meet MIL-STD-961. Moved classification under Scope (Section 1).

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1. SCOPE

This specification establishes materials requirements for Niobium-Hafnium-Titanium alloy commonly known as Nb C103 in powder form for use in Laser Beam Powder Bed Fusion (PBF-LB) additive manufacturing processes.

1.1. Classification

1.1.1. Class 1

Class 1 powder shall be produced using argon gas atomization process.

1.1.2. Class 2

Class 2 powder shall be produced using plasma atomization process.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. The effective issue of those document not specifically identified by revision identifier or date shall be the latest issue in effect. In the even of conflict between the documents referenced herein and the content of this specification, the content of this specification shall be the superseding requirement.

American Society for Testing and Materials (ASTM)

ASTM B215 Standard Practices for Sampling Metal Powder

Aerospace Materials Specification (AMS) by Society of Automotive

Engineers (SAE) AMS 7025 Metal Powder Feedstock
Classifications

3. REQUIREMENTS

3.1. Powder Composition

Each powder lot shall conform to the following chemical composition (by %):

TABLE I. Chemistry allowable for C103 powder.

Element	Class 1 As Received		Class 1 Reuse		Class 2 As Received		Class 2 Reuse	
	Min	Max	Min	Max	Min	Max	Min	Max
Hafnium	9	11	9	11	9	11	9	11
Titanium	0.7	1.3	0.7	1.3	0.7	1.3	0.7	1.3
Zirconium	0	0.7	0	0.7	0	0.7	0	0.7
Tungsten	0	0.5	0	0.5	0	0.5	0	0.5
Tantalum	0	0.5	0	0.5	0	0.5	0	0.5
Carbon	0	0.015	0	0.015	0	0.015	0	0.015
Oxygen	0	0.045	0	0.06	0	0.045	0	0.06
Nitrogen	0	0.015	0	0.015	0	0.015	0	0.015
Hydrogen	0	0.0015	0	0.0015	0	0.002	0	0.002
Other Elements, total	0	0.3	0	0.3	0	0.30	0	0.30
Niobium/Columbium	Remainder		Remainder		Remainder		Remainder	

Gaseous (Oxygen, hydrogen, and nitrogen) elements shall be determined by inert gas fusion analysis, carbon shall be determined via combustion method and other metallic elements by spectrochemical methods.

Alternative analytical methods may be used if approved by purchaser.

3.2. Particle Size Distribution

Each powder lot shall conform to the following particle size distribution per AMS 7025:

- a) Class 1: 15 μ m-53 μ m
- b) Class 2: 15 μ m-53 μ m, except up to 10% of +270 mesh allowed, and up to 35% of +325 to - 270 mesh particles allowed.

3.3. Powder Production

Powder shall be produced by the appropriate atomization method per its classification.

3.4. Powder Handling

Powder handling shall ensure the material produced is free of contamination by nonmetallic materials or foreign metallic particles.

3.5. Powder Uniformity and Cleanliness

Powder shall appear uniform in quality and appearance, with no foreign material visible.

3.6. Requirements to Blend Multiple Powder Heats and Lots

If powder heats are blended to create a powder lot, each powder heat must first be individually analyzed and determined to meet the requirements of Section 3. After blending, the powder lot must again be inspected, re-certified to meet the requirements of Section 3 and provided with certificate of conformance. The addition of metal powder other than powder conforming to the requirements of Section 3 to meet the requirements of Section 3 is prohibited.

3.7. Requirements to Mix Powder Classes

Mixing Class 1 and Class 2 powders is prohibited.

4. QUALITY ASSURANCE

4.1. Responsibility for Inspection

Powder producer is responsible for performing all inspections and tests required by this specification. Individual heats shall be inspected prior to mixing. All required tests for certification of the lot shall be conducted by a NADCAP certified laboratory and conform prior to delivery of a lot. The purchaser reserves the right to perform any additional inspection to confirm the material conforms to the requirements of this specification.

4.2. Sampling

Sampling of powder shall be in accordance with ASTM B215, or by another method approved by purchaser.

4.3. Certificate of Conformances

4.3.1. Chemical Analysis

Powder producer shall provide the purchaser with a certification of chemical analysis, including results for the elements specified in 3.1, the name of the analyzing lab, the date analyzed, and the analysis method. The certification shall report composition of the elements in weight percent.

4.3.2. Particle Size Analysis

Powder producer shall provide the purchaser a certification of the particle size analysis per 3.2 for each powder lot, including analyses for the mesh sizes, the name of the analyzing lab, the date analyzed, and the analysis method. The particle size analysis shall be representative of the entire powder lot.

4.3.3. Powder Production

Powder producer shall provide the purchaser with a certification that powder was produced by the appropriate atomization method per its classification.

4.3.4. Powder Handling

Powder producer shall provide the purchaser with a certification that powder was handled under controlled conditions that ensure no contamination by nonmetallic materials or foreign metallic particles.

4.3.5. Powder from Multiple Powder Heats

Powder producer shall provide the purchaser with a certification that all powder heats incorporated into a certified lot were separately analyzed and met the requirements of Section 3 prior to mixing. The final heat or lot (if blended) shall be identified on the certification.

4.4. Supplier Approval

4.4.1. New Supplier

A new powder producer seeking approval as an approved source shall submit a sample of at least 50 grams of material for evaluation to the requirements of Section 3. An additional amount to be specified by the powder purchaser will be required for evaluation of suitability for fabrication and qualification test articles.

4.4.2. Requalification

The powder producer shall be responsible for an immediate written notification of any change in composition, preparation, or processing of material approved to this specification. Requalification of the powder is at the discretion of the powder purchaser.

5. PACKAGING

5.1. Individual Containers

Powder shall be packaged in sealed containers to protect the powder from contamination and oxidation during shipment and under normal dry storage conditions. Seals used on containers shall be designed such that the seals must be destroyed upon opening the container.

5.2. Exterior Containers

Individual packages or containers shall be packed in an exterior shipping container capable of protecting the powder, during shipment and storage, against damage from exposure to weather or any normal hazard.

5.3. Shipping

Powder shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the powder to ensure carrier acceptance and safe delivery.

5.4. Marking

Each container of this material shall be labeled with the following information:

- a) Product Name (include alloy's common name and atomization process)
- b) Powder Size Distribution
- c) Individual Package Weight
- d) Powder Producer's Name
- e) Powder Lot Number
- f) Packaging Date
- g) Hazards Labeling

6. NOTES

6.1. Definitions

For the purpose of this specification, definitions of terms used within this specification are as follows:

6.1.1. Powder Heat

For batch processes, a powder heat is defined as a quantity of powder produced from one melt and atomization. For non-batch semi-continuously melted or continuous processes, a powder heat is defined as powder produced during an individual production cycle.

6.1.2. Powder Lot

A powder lot is defined as a quantity of powder manufactured under traceable controlled conditions, consisting either of powder from one powder heat, or of a uniform blending of powders originating from more than one powder heat, collectively inspected, certified, and provided with source documentation.

6.1.3. Powder Reconditioning

The process of altering the characteristics of powder in such a way as to make the powder acceptable for use as feedstock. This typically involves changing physical or chemical attribute of the powder volume as a whole or by removal of a subset of particles (e.g., mechanical sieving of oversized particles).

6.1.4. Reuse Powder

Used powder that has seen, at minimum, a single build cycle, recovered from an additive manufacturing process, reconditioned as necessary to modify its physical or chemical attributes, and potentially blended with similar lots of virgin or used powder, to be prepared for use as feedstock in the same additive manufacturing process.

6.1.5. Reuse Powder Lot

A designation of used powder prepared for reuse, shown to be conforming to an applicable powder specification, limited in mass and key characteristics such as size range and chemical composition.

6.1.6. Date Packed

Date packed is the date powder is transferred into the final containers.

APPENDIX A

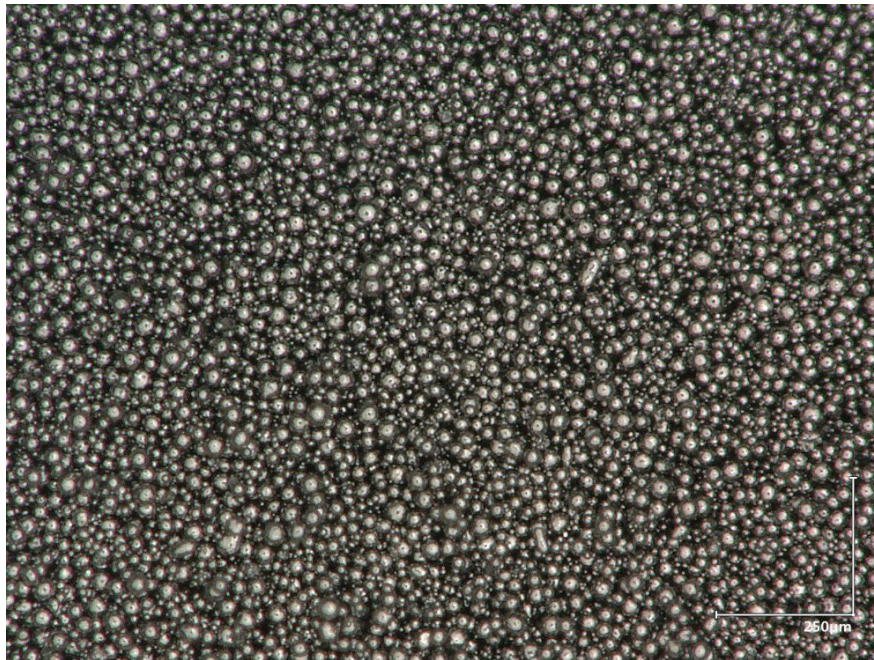


Figure 1 - Example of acceptable powder monolayer at 100X magnification

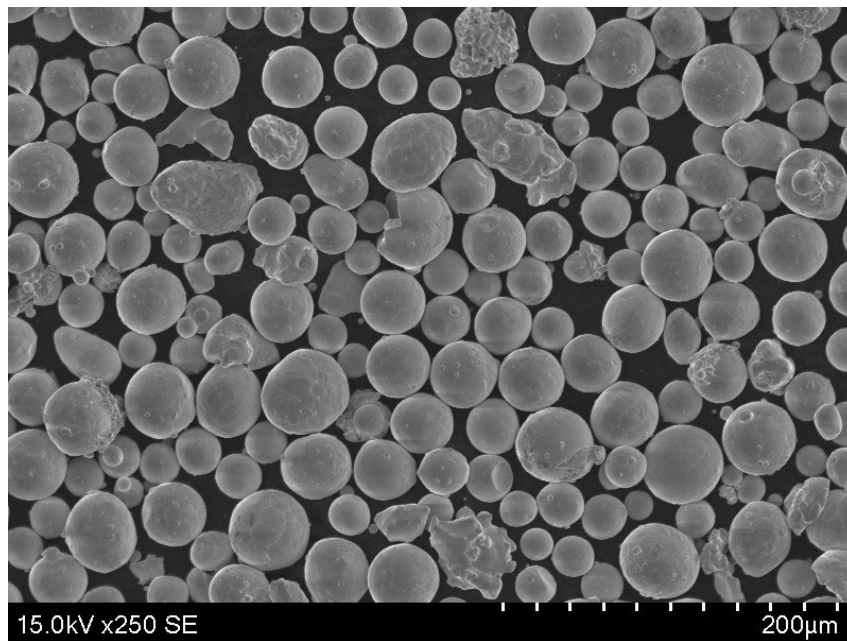


Figure 2 – SEM image of Class 1 acceptable powder morphology at 200X magnification

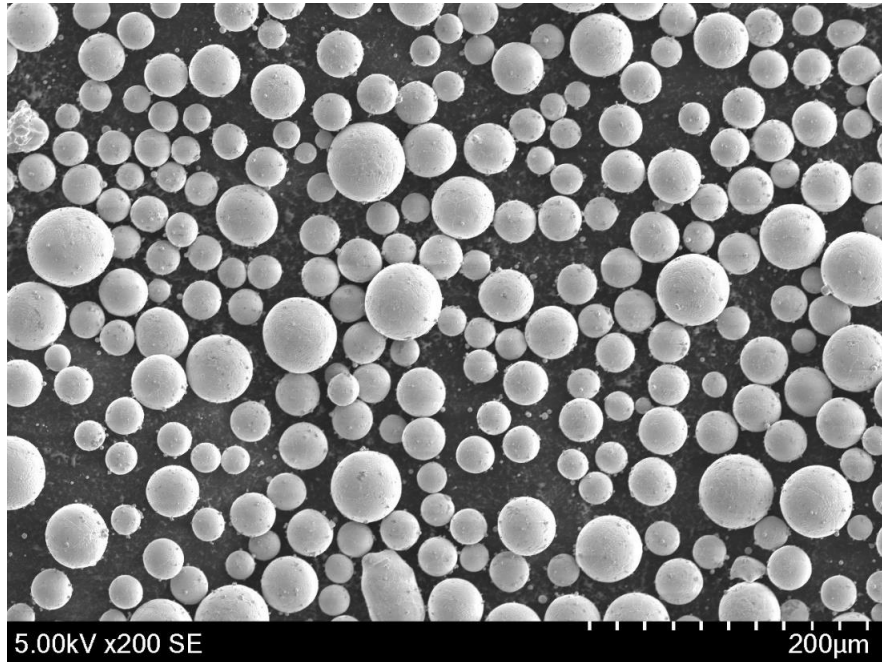


Figure 3 – SEM image of Class 2 acceptable powder morphology at 200X magnification

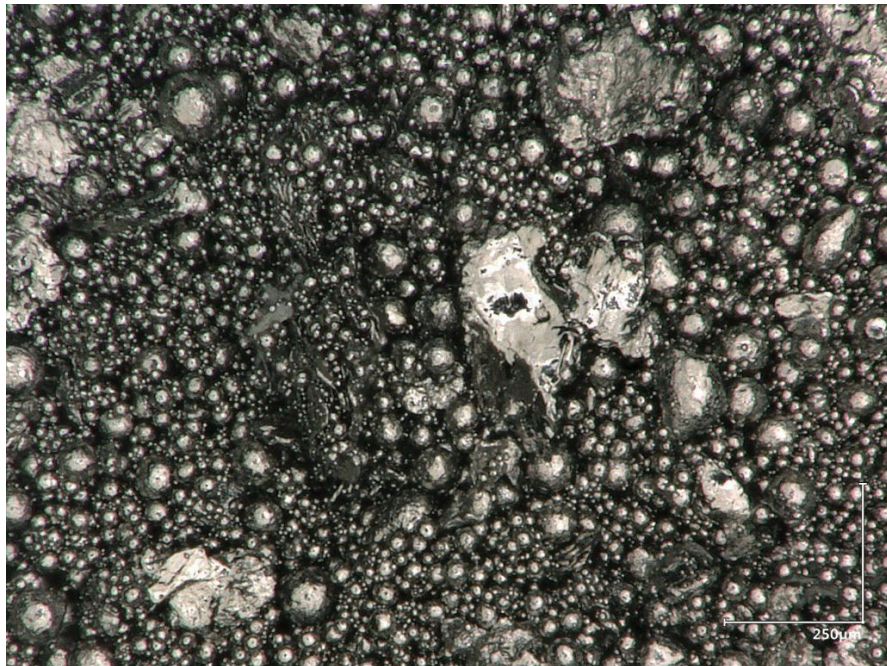


Figure 4 - Example of unacceptable powder monolayer at 200X magnification