Document No.: NMS 800/1 Rev B-,October 4th, 2024

NCAMP Material Specification

This specification is generated and maintained in accordance with NCAMP Standard Operating Procedures, NSP 100

Hexcel Corporation HexPEKK®-100 (Virgin Material only)

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REVISIONS:

Rev	By	Date	Pages Revised or Added
N/C	Michelle Man	10/25/2021	Document Initial Release
A	Jonathan John	11/22/2023	- Add specs limit - Updated spec limit for Flex and Compression prism to XY direction from TBD - Added thickness requirements to table 3 and removed it from table 2, as thickness varies by test method - Added note 6 for table 3
B	Jonathan John	10/4/2024	-Page 4, note 1, added the sentence “See approved PCD for accepted ASTM deviations”. In note 1, and change “ave” to “avg” for note 2 -Page 5, table 3, updated average thickness to nominal thickness. Added “derivatives and controlled data set procedures” to notes 3, 4 and 5

1. SCOPE:

1.1 Form:

This detailed specification along with the base specification NMS 800 establishes the requirements for the manufacturing of aerospace laser powder bed fusion (LPBF) powder.

The base specification shall govern where no additional requirement is specified; in such cases, the applicable sections are omitted from this detail specification.

2. Type: All products qualified to this detail specification have the following classification: HexPEKK®-100 Powder.

3. Material Testing Requirements:

3.1 Powder Physical Properties

Table 1 Powder Physical Properties

Property(1,2)	Number of Tests per Lot	Requirements
FTIR Match %(3)	1	≥ 95% match, ind
Particle Size (4)	3	See approved PCD document Section 4 for controlled range
DSC(5)	1	152°C - 165°C, ind

(1) Specific procedures should be identical to those used in the original material qualification program. See section 8 of NMS 800 for material test methods

(2) “ind” refers to individual measurements. “avg” refers to the average measurements. “max” refers to maximum measurement.

(3) Fourier-Transform Infrared (FTIR) spectroscopy comparison versus powder standard. Powder standard shall be the same standard used in qualification. This testing is the responsibilities of the manufacturer and need not to be repeated by the purchaser.

(4) Manufacturer is to measure particle size D50 from a single unique lot. This testing is the responsibilities of the manufacturer and need not to be repeated by the purchaser.

(5) Measure glass transition temperature in accordance with ASTM D3418. Heat rate of 20°C/min and a 9-11 mg sample size.

3.2 As-printed Specimen Physical Properties

Table 2 As-printed Specimen Physical Properties

Property	Test Method[1]	Requirements[2]
Thickness	In accordance with applicable mechanical test method	See Table 3
Density	ASTM D792	1.314 ± 0.05 g/cc, avg

[1] Specific procedures should be identical to those used in the original material qualification program. See approved PCD for accepted ASTM deviations.

[2] Computed from actual qualification printed specimens thicknesses. A minimum of 3 thickness measurements per specimen was taken. “Avg” refers to the average of 5 specimens.

3.3 As-printed Specimen Mechanical Properties

Table 3 As-printed Specimen Mechanical Properties

Property	Test Method(1)	Requirements(2)	Thickness Requirements (6)
Tension Strength and Modulus(3) Room Temperature, Ambient Orientation: ZX	ASTM D638 DF2 Geometry	Strength: Min. Ind. ≥ 8.400 ksi Strength: Average ≥ 10.19 ksi Modulus: 0.6569 to 0.7658 msi, avg	0.1357 to 0.1481 inch, (0.13 nominal)
Compression Strength and Modulus(4) Room Temperature, Ambient Orientation: XY	ASTM D695 Prism	Strength: Min. Ind. ≥ 24.30 ksi Strength: Average ≥ 25.32 ksi Modulus: 0.980 to 1.059 msi, avg	0.4888 to 0.5066 inch, (0.50 nominal)
Flex Strength and Modulus(5) Room Temperature, Ambient Orientation: XY	ASTM D790	Strength: Min. Ind. ≥ 20.85 ksi Strength: Average ≥ 24.78 ksi Modulus: 0.775 to 0.875 msi, avg	0.1408 to 0.1546 inch, (0.13 nominal)

(1) Specific procedures should be identical to those used in the original material qualification program.

(2) "ind" refers to individual measurements. "avg" refers to the average of 5 specimens.
To be conducted by either Manufacturer or Purchaser: A set of 5 specimens is required from each powder lot that may be used to produce multiple powder drums by the manufacturer.
Limits computed at α=0.01 and modified CV. *Specimens should be distributed randomly within the build volume and shall not be sampled from one build location only..*

(3) Specimens are printed per "Tension SL.SLI" derivatives and controlled data set procedures. Material supplier is required to print the specimens per NPS 89800 latest version. Modulus strain range: 1,000 to 3,000 $\boldsymbol{\mu\varepsilon}$. per ASTM D638 modified DF2 geometry shown in Appendix A of NMS 800.

(4) Specimens are printed per "Compression SL.SLI" derivatives and controlled data set procedures.. Material supplier is required to print the specimens per NPS 89800 latest version. Modulus strain range: 1,000 to 3,000 $\boldsymbol{\mu\varepsilon}$ per ASTM D695.

(5) Specimens are printed per "Flex SL.SLI derivatives and controlled data set procedures.". Material supplier is required to print the specimens per NPS 89800 latest version. Modulus strain range: 5,000 to 20,000 $\boldsymbol{\mu\varepsilon}$ using deflectometer. Span length is 16T, T=Average Specimen Thickness.

(6)Computed from actual qualification printed specimen thicknesses. A minimum of 3 thickness measurements across the specimen width and length (per applicable ASTM requirements) using an appropriate measuring device. "avg" refers to average measurements; limits computed at α=0.01.

QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout(1)
HexPEKK®-100	Supplier Name: Hexcel Corp. Production Location: Hexcel 250 Nutmeg Rd S. South Windsor, CT 06074 Approved Process Equipment: Group A (see PCD)	TBD	NMS 800/1 Classification callout is not applicable in this QPL.

(1) In accordance with NCAMP Standard Operating Procedures, NSP 100, this QPL shall not contain alternate materials/products. Additional production location may be included in the QPL only after successful equivalency demonstration and approval per NCAMP Process Control Document (PCD) Preparation and Maintenance Guide, NRP 101.

(1) The proper specification callout for material procurement purpose is “NMS 800/1.” This specification is developed based on the material properties that are available publicly. The purchaser may specify additional requirements beyond those specified in this specification, especially when the purchaser has generated additional material properties beyond those available publicly or when the application requires additional requirements. The additional requirements are subject to supplier review and approval.