

## I-70-H GRADE BERYLLIUM BLOCK

Effective: March 29, 2012

Revision C

### 1. SCOPE

- 1.1. This specification defines the requirements for an optical grade of beryllium designated as I-70-H. This grade is a high purity, low oxide material with good polishing characteristics. It is to be produced through the consolidation of beryllium powder by Hot Isostatic Pressing (HIP).

### 2. CHEMICAL COMPOSITION

The chemical composition shall conform to the following:

Beryllium Assay, % minimum (1)	99.0
Beryllium Oxide, % maximum (2)	0.7
Aluminum, % maximum (3)	0.07
Carbon, % maximum (4)	0.07
Iron, % maximum (3)	0.10
Magnesium, % maximum (3)	0.07
Silicon, % maximum (3)	0.07
Other Metallic Impurities, % maximum (3)	0.04

- Note: (1) Difference (i.e. 100%-other elements)  
(2) Leco Inert Gas Fusion  
(3) Spectrochemical Methods  
(4) Leco Combustion

### 3.DENSITY

3.1. The minimum bulk density shall be 99.7% of Theoretical Density.

3.2. The theoretical density is to be calculated using the following formula:

$$\text{Theoretical Density} = \frac{100}{\frac{100 - \% \text{ BeO}}{1.8477 \text{ gm/cc}} + \frac{\% \text{ BeO}}{3.009 \text{ gm/cc}}} \text{ gm/cc}$$

3.3. Density shall be determined using the water displacement method.

### 4.THERMALLY INDUCED POROSITY (TIP) RESISTANCE

4.1. A sample shape from each HIP'd lot or sample material from material produced as an integral part (prolongation) of each HIP'd shape shall be subjected to a TIP test consisting of a heat treatment in a predominantly inert atmosphere at a temperature of 1450°F (788 C).

4.2. The minimum material density allowed following the TIP heat treatment shall be 99.7% of the Theoretical Density, calculated as shown in section 3.2. The maximum drop in the density due to the TIP Resistance Test is to be 0.20%.

### 5.TENSILE PROPERTIES

5.1. Minimum tensile properties for the material at room temperature, as determined per ASTM E8 and MAB-205M, shall be:

Ultimate Tensile Strength, ksi, minimum	50.0 (345 Mpa)
Yield Strength (0.2% offset), ksi, minimum	30.0 (207 Mpa)
Elongation (% in 4 diameters), minimum	2.0
Micro-Yield Strength, ksi	3.0

Micro-Yield Strength will be measured in two directions for each lot produced, if requested.

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- 5.2 Mechanical properties shall be determined for each lot of shapes, defined by each combination of powder lot (blend) and HIP run. The properties may be determined from a sample shape or from material produced as an integral part (prolongation) of a HIP'd shape from the lot.

## 6. COEFFICIENT OF THERMAL EXPANSION

- 6.1. The linear Coefficient of Thermal Expansion (CTE) will be measured in three orthogonal directions for each lot produced to this specification. The overall CTE from 5°C to 65°C will be reported for each direction.

## 7. PENETRANT INSPECTION

- 7.1. Penetrant and Visual Acceptance Criteria.

- A. Cracks are not permissible.
- B. Indications (as determined by penetrant):
  - 1. The size of an individual indication on the surface may not exceed 0.050" (1.27mm).
  - 2. A maximum of 3 indications of the size 0.003" (0.08mm) to 0.050" (1.27mm) per square inch (650mm<sup>2</sup>) of the surface is acceptable.
  - 3. No restrictions to size or number if they do not hold penetrant.

- 7.2. Penetrant inspection shall be performed per ASTM E 1417, using penetrants and a dry developer conforming to MIL-I-25135, Type 1, Level 2, Method B, Form A.

## 8. RADIOGRAPHIC INSPECTION

- 8.1. Radiographic inspection to a penetrameter sensitivity of 2% shall be performed in accordance with ASTM E 1742, however, exceptions are taken to the penetrameter contrast requirement and applicable area of penetrameter density ranges of +30% or -15% from the density at penetrameter location(s).

**Note: Due to the nature of radiographic inspection, it is pointed out that the sensitivity of the inspection method decreases with the increasing material thickness.**

- 8.2. Radiographic indications (voids and/or inclusions) shall conform to the requirements as established and defined below.

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### 8.2.1. Requirements.

Material shall conform to the following requirements, as defined in 8.2.2.

Maximum Dimension	Maximum Average Dimension	Total Combined Volume per Cubic Inch
0.030 inch	0.020 inch	Sphere 0.050 inch diameter
(0.76mm)	(0.51mm)	Sphere 1.27mm diameter

### 8.2.2. Dimensions:

#### 8.2.2.1. Maximum Dimension of any Indication.

Any dimension of any indication measured in the plane of the radiograph shall not exceed the indicated size.

#### 8.2.2.2. Maximum Average Dimension of any Indication.

The average dimension of an indication shall be the arithmetic average of the maximum and minimum dimensions measured in the plane of the radiograph. The average dimension of an indication shall not exceed the indicated average.

#### 8.2.2.3. Total combined Volume per Cubic Inch of all Indications.

The total combined volume per cubic inch ( $16.4 \text{ cm}^3$ ) of all indications with an average dimension larger than 0.001 inch (0.025mm) shall not exceed the volume of a sphere of the indicated volume.

#### 8.2.2.4. The minimum detectable size of voids and inclusions will increase as the section thickness increases, due to the decrease in sensitivity referred to in paragraph 8.1.

#### 8.2.2.5. Part Density Uniformity.

The terms variable density areas, banding or striations shall denote relatively large areas of a radiograph which vary in density as compared to the surrounding area. These areas shall not vary in radiographic density by more than 5% as compared to the surrounding area of comparable section thickness.

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8.2.2.6. Light high density indications or areas in material 1.000" (25.4mm) thick or less which are 5% or less in radiographic density compared to the surrounding material are acceptable.

## 9. GRAIN SIZE

- 9.1. The average grain size shall be determined in accordance with ASTM E-112, using the intercept method at 500 magnification.
- 9.2. The average grain size shall not exceed 12 microns.

## 10. TOLERANCES

- 10.1. Materials furnished under this specification shall conform to the dimensions and dimensional tolerances as established by the purchase order and applicable drawings. If tolerances are not specified by the purchase order, the following standard tolerances shall apply employing ANSI 14.5M:

Diameter, Width or Thickness (Inches)	Tolerance
Up to 3, inclusive	-0 + 1/64
Over 3 to 20, inclusive	-0 + 1/16
Over 20	-0 +1/4

Length (Inches)	Tolerance
Up to 20, inclusive	-0 +1/8
Over 20	-0 +1/4

Diameter, Width or Thickness (Millimeters)	Tolerance
Up to 76, inclusive	-0 +0.40
Over 76 to 508, inclusive	-0 +1.59
Over 508	-0 +6.35

Length (Millimeters)	Tolerance
Up to 508, inclusive	-0 +3.18
Over 580	-0 +6.35

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## 11. SURFACE FINISH

- 11.1. The material shall be furnished with a machined surface. The standard surface finish shall be 125 micro inches rms. (Approximately = 110 Ra) maximum, employing ANSI/ASME B46.1.

## 12. REPORTS

- 12.1. Certifications of Compliance with this specification will be furnished on request and, when specified, actual test results will be certified. Testing in accordance with individual customer instructions will be performed if mutually acceptable and actual test results will be certified.

## 13. MARKING

- 13.1. Surface permitting, each part will be legibly marked employing an electro etching technique or tagging if insufficient area is available.
- 13.2. Marking is to include the following:

Materion Brush Inc.  
Lot and/or Part Number  
Serial Number  
Specification Number  
X-Ray Number  
Purchase Order Number  
Warning Beryllium

## 14. SAFETY / ENVIRONMENTAL

- 14.1 Handling Beryllium Containing Material in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on Beryllium Containing Material, contact Materion Brush Beryllium & Composites, EH&S Product Steward @ 216-383-4040

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