MATERION

SPEC SHEET

# O-30-H GRADE BERYLLIUM

Effective Date: April 2. 2012 Rev. A

1. Scope

1.1. This specification establishes the material requirements for an optical grade of hot isostatically pressed (HIP) beryllium, suitable for low scatter optical applications. This is a high density, high purity, low oxide material with good polishing characteristics.

2. Chemical Composition

2.1. The chemical composition shall conform to the following:

| | |
|---|---|
| Beryllium Assay, % minimum (1) | 99.0 |
| Beryllium Oxide, % maximum (2) | 0.50 |
| Aluminum, % maximum (3) | 0.07 |
| Carbon, % maximum (4) | 0.12 |
| Iron, % maximum (3) | 0.12 |
| Magnesium, % maximum (3) | 0.07 |
| Silicon, % maximum (3) | 0.07 |
| Other Metallic Impurities, each, % 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 actual bulk density shall be equal to or greater than 99.7% of the Theoretical Density, after the material has been stress relieved.

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

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

**BRUSH BERYLLIUM & COMPOSITES**
14710 W Portage River South Rd
Elmore, OH 43416-9502
P: 419.862.4533 or 419.862.4171 Intl: 419.862.4127
e: beryllium@materion.com

**MATERION BRUSH INC.**
www.materion.com/beryllium

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

4. Thermally Induced Porosity (TIP) Resistance

4.1. Sample material shall be subjected to a TIP test consisting of a heat treatment in 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 E-8 and MAB-205M, shall be:

| | |
|---|---|
| Ultimate Tensile Strength | 50.0 Ksi(345 Mpa) Minimum |
| Tensile Yield Strength | 30.0 Ksi(207 Mpa )Minimum |
| Elongation | 2.0% Minimum |
| Micro-Yield Strength | 3.0 Ksi (21 Mpa) Minimum |

5.2. Federal Test Method Standard No. 151 is applicable.

6. Coefficient of Thermal Expansion

The linear Coefficient of Thermal Expansion (CTE) will be measured in three orthogonal directions for each pressing produced to this specification. The overall average CTE from 41°F( 5°C) to149°F (65°C) will be reported for each direction. (Typically 11.2 - 11.3 ppm/°C).

7. Penetrant Inspection

7.1. Penetrant and Visual Acceptance Criteria

A. Cracks are not permissible.

B. Pores (as determined by penetrant):

1. The size of an individual indication on the surface may not exceed 0.050” (1.27 mm).

2. A maximum of 3 indications (of the size 0.003” (0.08 mm) to 0.050” (1.27 mm)) per square inch (650 $mm^2$) 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-1-25135, Type I, Level 2, Method B, Form A.

8. Radiographic Inspection

8.1. Radiographic inspection to penetrameter sensitivity of 2% shall be performed in accordance with ASTM E1742. However, exceptions are taken to the penetrameter contrast requirement and the applicable area of penetrameter density ranges of +30% or -15% from the density at penetrameter locations. The decision to accept or reject may be made directly beneath the penetrameters.

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

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

8.2.1. Material shall conform to the following requirements.

| Maximum Dimension | Maximum Average Dimension | Total Combined Volume per Cubic Inch |
|---|---|---|
| 0.050”(127mm) | 0.030”(0.076mm) | Sphere 0.050”(1.27mm) diameter |

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 $cm^3$) of all indications with an average dimension larger that 0.001 inch (0.025 mm) 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 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 that 5% as compared to the surrounding area of comparable section thickness.

8.2.2.6. Light high density indications or areas in material 1.000” (25.4 mm) thick or less, which are 5% or less in radiographic density compared to the surrounding material, are radiographically 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 15 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 purchase order, the following standard tolerances shall apply employing ANSI Y 14.5M:

| Diameter, Width or Thickness | Tolerance |
|---|---|
| Up to 3”(76mm), inclusive | -0, + 1/64”( -0, + 0.40mm) |
| Over 3”(76mm) to 20”(508mm), inclusive | -0, + 1/16”( -0, + 1.58mm) |
| Over 20”(508mm) | -0 ,+ 1/4”( 0, + 6.35mm) |

| Length, | Tolerance |
|---|---|
| Up to 20”(508mm), inclusive | -0 + 1/8”(-0, + 3.18mm) |
| Over 20”(508mm) | -0 + 1/4”(-0, + 6.35mm) |

11. Surface Finish

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

12. Reports

12.1. Certification 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.

Note: The reported density and tensile properties shall be representative of the shapes in the as-HIP’d and stress relieved condition.

13. Marking

13.1. Surface permitting, each part shall be legibly marked employing an electroetching 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. Health and Safety

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

.