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Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 424-6424
Telex 24-5454

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Lawrence Livermore Laboratories
University of California
P. O. Box 808
Livermore, California 94550

Attention Mr. James Jepson
Special Materials Group

Gentlemen:

SANL 507-014

This is the final report on the subject SANL, concerning the fabrication of beryllium hemispheres. The period covered is August 1 to September 30, 1977. The responsibility for this program was in the Materials Application Section under Dr. Dale E. Niesz, Manager and Kenneth E. Meiners, Associate Manager. Roy McIntire was directly responsible for the program.

Objective

The objective of the program was to fabricate two hemispheres from high-purity (P-1) beryllium powder by hot-isostatic pressing (HIP) of cold-isostatically pressed (CIP) preforms and supply the parts to Union Carbide Corporation, Nuclear Division, Oak Ridge, Tennessee. The parts were to conform to LLL drawing AAA-76-114-924-00.

Approach

Prior experience at Battelle in fabricating similar hemispherial shapes (Report of January 3, 1977 on SANL 507-003) suggested that the parts could be made in the following steps:

(1) CIP the powder on stainless steel hemispherical mandrels to form a powder shell having the desired inside contour and suitable wall thickness.

(2) Machine excess material off the outside surface to provide the proper outside contour and wall thickness.

(3) Place a preformed thin-walled mild steel can over the CIP part and weld the can to the mandrel at its base.

(4) Draw a vacuum on the part by means of a mechanical pump connected to outgassing stems (1/4-in. OD tubing) previously welded to the can.

(5) Place the assembly in a cold muffle-furnace and heat to 1200 F. Hold temperature and vacuum until outgassing essentially ceases (maximum pressure rise of 1 mm in 15 minutes).

(6) Hammer flat and cut off outgassing items and weld the cut to provide a final vacuum tight seal. Cool to room temperature.

(7) Place in a cold HIP autoclave and simultaneously heat and pressurize to 1400 F and 15,000 psi. Hold conditions for 3 hours.

(8) Simultaneously cool and depressurize to ambient conditions.

(9) Machine the mild steel can from the mandrel base and strip the remaining can off the beryllium.

(10) Lift the beryllium part off the mandrel.

Fabrication of Parts

P-1 beryllium powder for making the parts was available from that purchased for the previous program, SANL 507-003. Powder loading, CIP, canning, outgassing, and HIP were performed in the same manner as before. The CIP pressure was 60,000 psi and HIP conditions were 15,000 psi and 1400 F for 3 hours.

Results and Discussion

Both of the mild steel containers developed leaks during the HIP run. Although the can material was the same as before (16 gage aluminum-killed Type 1008 steel) and the same processing procedure was used, a small rupture developed in each can.

The ruptures occurred at the junction of the beryllium and the tapered base of the mandrel. (Figure 1 shows sectional views through the mold assemblies before CIP and also before HIP). The mild steel can was forced between the beryllium and steel mandrel until it failed locally by cracking. Repair was effected by weld depositing mild steel in the areas which had deformed. The assemblies were again out-gassed at 1200 F, sealed off, and re-HIP processed.

The weight of powder used in each part and the weights after HIP are in Table 1. The table also contains dimensions and densities measured on each part. Density for both parts was 1.853 g/cc. Thus, the parts were fully densified. The Handbook density for solid beryllium is 1.85 g/cc. The dimensions after HIP were close enough to the print dimensions to provide adequate material for clean up without an expensive amount of machine loss.

The two beryllium hemispheres were shipped on September 14, 1977.

If you have any questions or comments about this report, please call me at (614) 424-7915. We have enjoyed working with LLL Personnel on this interesting project and will be pleased if we can be of service in the future.

Very truly yours,

Kenneth E. Mcintire for

Hoy O. McIntire
Senior Research Metallurgist
Materials Application Section

cc: Dr. A. B. Copeland
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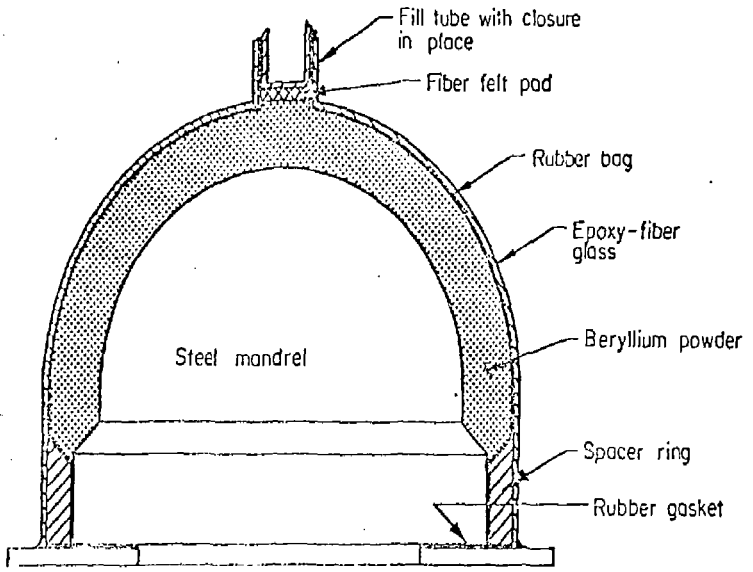
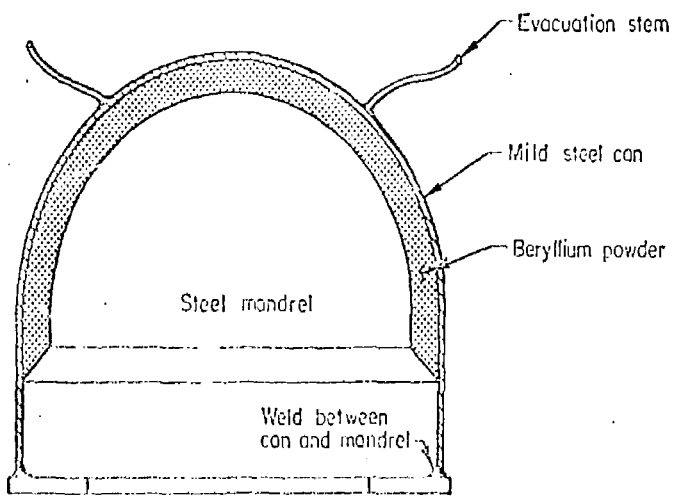


a. Mold Filled With Powder



b. Mold Ready For Hip

FIGURE 1. SECTIONAL VIEWS THROUGH MOLDS

TABLE 1. PERTINENT DATA RELATIVE TO BERYLLIUM PARTS

Part	CIP wt. lb.	HIP wt. lb.	Diameter In. Inside	Diameter In. Outside	Wall Thickness, in.	Density, g/cc (a)
A	17.19	14.25	7.96	10.33	1.18	1.853
B	17.59	14.29	7.95	10.30	1.18	1.853
Drawing Dimensions			8.00 max.	10.25 min.	1.12 min.	

(a) Density measured by immersion technique.