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EFFECT OF STRAIN-GAGE SURFACE PREPARATION TECHNIQUES ON BERYLLIUM

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THE EFFECT OF STRAIN-GAGE SURFACE PREPARATION TECHNIQUES ON BERYLLIUM

ABSTRACT

Beryllium is a metal sensitive to machining damage, causing a loss in mechanical properties. Since some mechanical abrading is often used in surface preparation for mounting strain gages, it is desirable to know whether the abrading produces flaws. Metallographic study of beryllium subjected to four different surface preparation methods was carried out. It was determined that the gentle abrading necessary for affixing strain gages produced a negligible density and depth of flaws and did not lower the mechanical properties.

INTRODUCTION

The susceptibility of beryllium to machining damage is well known.¹ The application of a machine tool can easily produce microcracks and twins in the beryllium, which may seriously degrade the mechanical properties. In preparing to mount strain gages the surface is mechanically abraded to insure that the gage will reliably adhere. Ordinarily these procedures do not measurably change the dimensions of the metal or alter the stress in test parts. However, when considering beryllium's sensitivity to surface damage, it is logical to be concerned about the possible degradation of mechanical properties during strain-gage surface preparations.

The degree of beryllium degradation by surface preparation is particularly important because strain gages are usually mounted on tensile specimens or on critical regions of fabricated parts — the exact locations where surface damage would be most harmful.

With this study, we hoped to ascertain the effect of typical surface-preparation techniques on powder-origin beryllium.

EXPERIMENTAL

The beryllium was impact attritioned and isostatically pressed (pressing T209).² Its pertinent properties are shown in Table 1.

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Table 1. Properties of beryllium (pressing T209).

Ultimate strength	557 MPa
Yield strength	395 MPa
Elongation	3.9 %
BeO	1.8 %
Grain size	5 μ m

Flat test areas, approximately 25 mm square, were carefully ground on test coupons 1.27 mm thick. All effects of grinding damage were removed by chemically etching 0.076 mm off the surface.

The test coupons were then subjected to four surface preparation procedures suitable for mounting a variety of strain gages. These procedures are outlined in Table 2. All abrading and grit-blasting preparations were conducted under wet or enclosed (non-hazardous) conditions.

Table 2. The procedures by which the test coupons were prepared for strain gages.

Method A	Method B	Method C	Method D
1. Wash with ethyl alcohol	1. Wash with ethyl alcohol	1. Wash with ethyl alcohol	1. Wash with ethyl alcohol
2. Abrade with -320 grit w/d, medium pressure. Constantly wet with distilled water. Rub for 20 s.	2. Abrade with -320 grit w/d, medium pressure. Constantly wet with distilled water. Rub for 20 s.	2. Grit blast with 25 μ m silicon carbide for 20 s from 50 mm.	2. Grit blast with 50 μ m silicon carbide for 20 s from 50 mm.
3. Abrade in a cross-hatch pattern.	3. Abrade in a random circular pattern.	3. Rinse with distilled water.	3. Rinse with distilled water.
4. Rinse with distilled water.	4. Rinse with distilled water.		

Following the strain-gage surface preparation, the specimens were cross sectioned and prepared for metallographic examination. Great care was exercised to avoid introduction of flaws at the edge of the specimen directly below the strain-gage preparation surface. It was particularly important to avoid the creation of twins.

RESULTS AND DISCUSSION

Compared to a typical machining or grinding operation, the strain-gage surface preparation techniques are quite gentle. Thus, it may be expected that microcracks and gross plastic distortion would not be present, and, indeed, such evidence of major surface damage was not found. The primary concern was the creation of twins.

None of the four surface-preparation methods caused a significant amount of twinning. Extensive examination of the four specimens revealed only a very small number of twins in isolated grains and only a grain deep in specimens B and D (Figs. 1 and 2). No twins were found in specimens A and C (Figs. 3 and 4).

Fig. 1. The specimen of beryllium prepared by Method B shows only a small number of twins in a layer only a grain deep. (Magnification - 200 $\times$.)

Fig. 2. As with Fig. 1, this specimen, prepared by Method D, shows only a small number of twins in a layer only a grain deep. (Magnification - 200 $\times$.)

Fig. 3. This specimen, prepared by Method A, shows no twins. (Magnification - 200 $\times$.)

Fig. 4. This specimen, prepared by Method C, shows no twins. (Magnification - 200 $\times$.)

For comparison, Fig. 5 shows of the depth and density of twins that proved harmful to mechanical properties in a previous study.¹ One variable not addressed in the present study, grain size, may have some effect, but we believe that our rather gentle surface preparation techniques would not cause grain size to be a significant variable.

We have concluded that the four methods of strain-gage surface preparation in this study will not degrade the mechanical properties of powder source beryllium.

Fig. 5.1 Cross section of a specimen prepared in another study¹ showing a thickness and concentration of twins that is harmful to the mechanical properties of beryllium. (Magnification - 200×.)

REFERENCES

1. J. E. Hanafée, *Effect of Machining Damage on Properties of Impact-Ground Beryllium*, Lawrence Livermore Laboratory, Rept. UCRL-52287 (1977).
2. This powder-source beryllium (pressing T209) was produced by the KBI Company in Reading, Pa.

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