ROOM TEMPERATURE FATIGUE BEHAVIOR OF CuCrZr OF TWO SIZES

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OBJECTIVE

The object of this effort is to supply data on the performance of copper alloys selected for ITER and other fusion applications.

SUMMARY

The room temperature fatigue behavior of unirradiated CuCrZr in two specimen sizes has been measured. The fatigue performance was found to be intermediate to those of OFHC copper and CuAl25, which were reported earlier. The size effects correlation is complicated somewhat by the sensitivity of this alloy to details of the heat treatment. Declining interest in this alloy for ITER applications and the shut-down of EBR-II will probably preclude irradiation of this alloy.

PROGRESS AND STATUS

Introduction

In an earlier report data on the room temperature fatigue behavior of OFHC copper and CuAl25 were presented for two different specimen sizes.[1] One size was the ASTM standard size and the other was a smaller size specimen developed to fit in available irradiation capsules. Irradiations of the subsize specimens of OFHC and CuAl25 in EBR-II are now complete and the irradiated specimens have been shipped to Denmark for testing.

The ITER project has also considered the use of another alloy, designated CuCrZr, although the commitment to use this alloy recently appears to be waning in favor of CuAl25. In the interim, however, a limited series of fatigue tests on this alloy in the unirradiated condition have been completed. The specimen sizes and test conditions used for CuCrZr were identical to those employed in earlier tests on OHFC and CuAl25.[1]

RESULTS

Fully reversed cyclic fatigue tests have been performed on CuCrZr at room temperature. The tests were performed in strain control on both standard and subsized specimens. The results cover a limited range of fatigue lives, only about an order of magnitude, but provide a good relative indication of how this alloy will perform in fatigue. As shown in Figures 1 and 2, the response falls between CuAl25 and OFHC Cu room temperature fatigue performance, as observed in an earlier phase of this program. Limited testing on the CuCrZr alloy is continuing to complete the characterization of the room temperature fatigue response, particularly for higher fatigue lives than those tested to date.

As shown in Figure 3, the subsize specimens show somewhat lower lives at the same strain range than do the standard size specimens. More important is the fact that the elastic response is lower and the plastic response higher for the subsize specimens, indicating that the subsize specimen material is somewhat softer than that of the standard size specimens. This appears to be due to relatively minor differences in alloy heat treatment for the two sizes. The properties of this alloy are known to be very sensitive to heat treatment and production technique. This sensitivity is one of the major reasons that this alloy is being dropped from consideration.

Microstructural analysis of the alloy conducted on both specimens sizes, taken both before and after fatigue testing, indicate that a fine dispersion of precipitates is found uniformly distributed throughout the matrix. The precipitates have not yet been fully identified, but are comprised of Cu, Cr and Zr. Grain boundary precipitates are found to be discontinuously distributed along many, but not all grain boundaries. In addition, large precipitates of essentially pure Cr are found throughout the matrix. The post-fatigue microstructure consists of dislocation subgrains.

Not only has the interest of ITER in this alloy waned, but the shut-down of EBR-II has interrupted plans for the irradiation of subsize CuCrZr specimens. No further work is planned until better definition of the need is established.

REFERENCES

1. A. Singhal, J. F. Stubbins, B. N. Singh and F. A. Garner, *J. Nucl. Mater.* 212-215 (1994) 1307-1312.

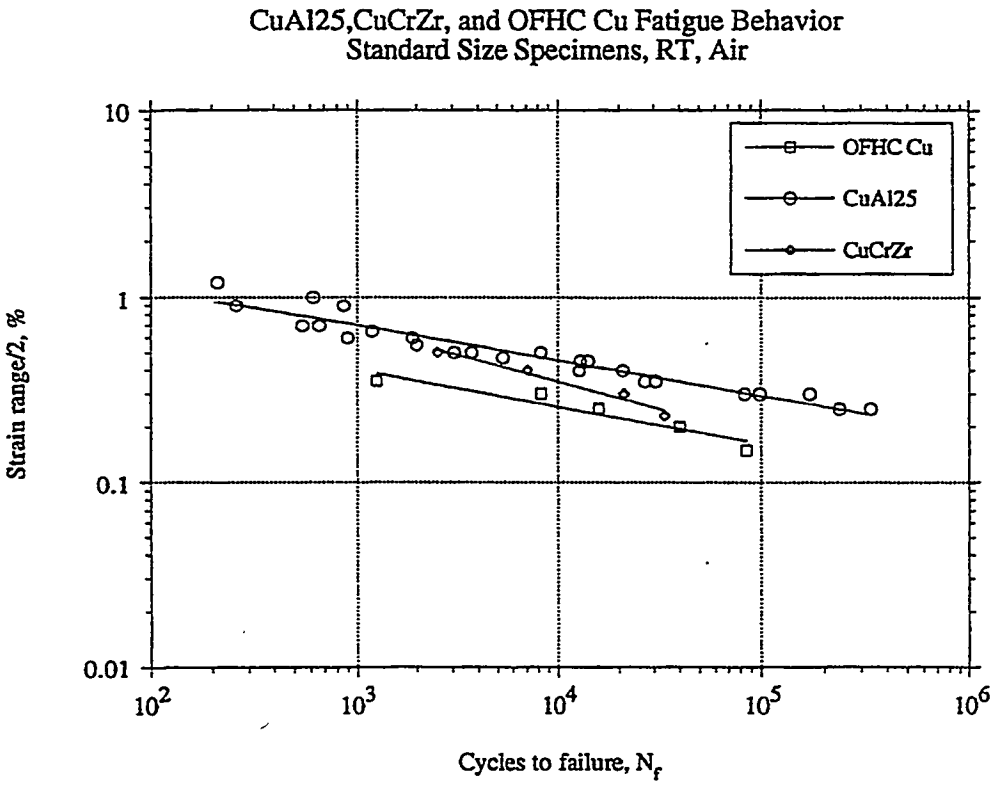

Figure 1. Fatigue response of standard size specimens

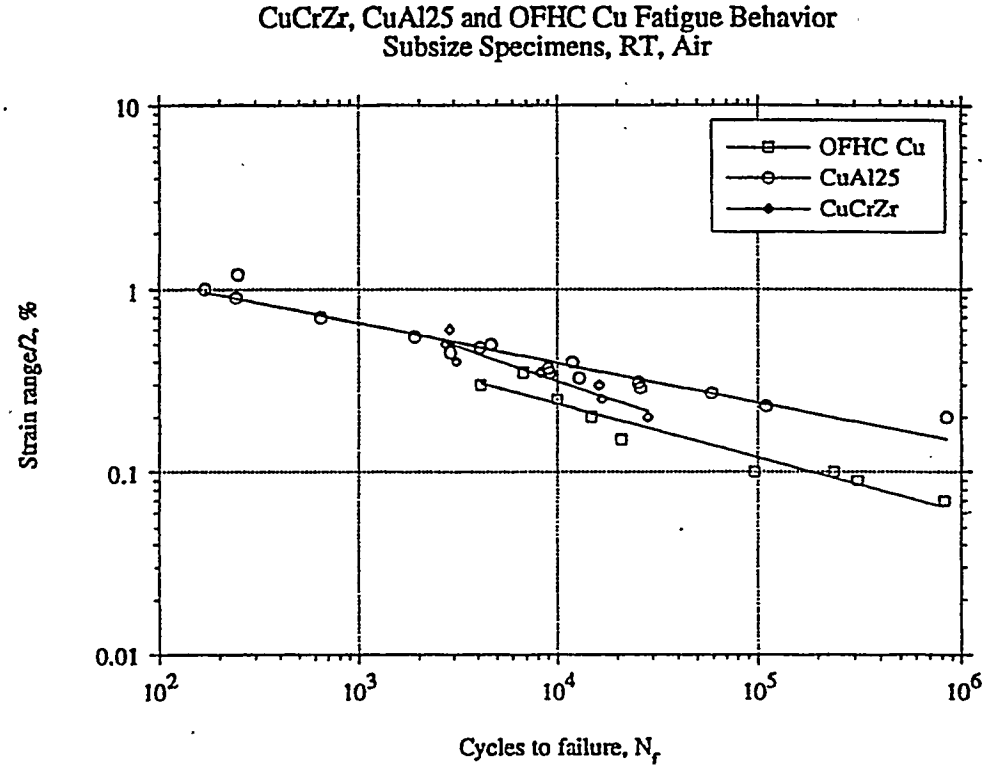

Figure 2. Fatigue response of subsize specimens

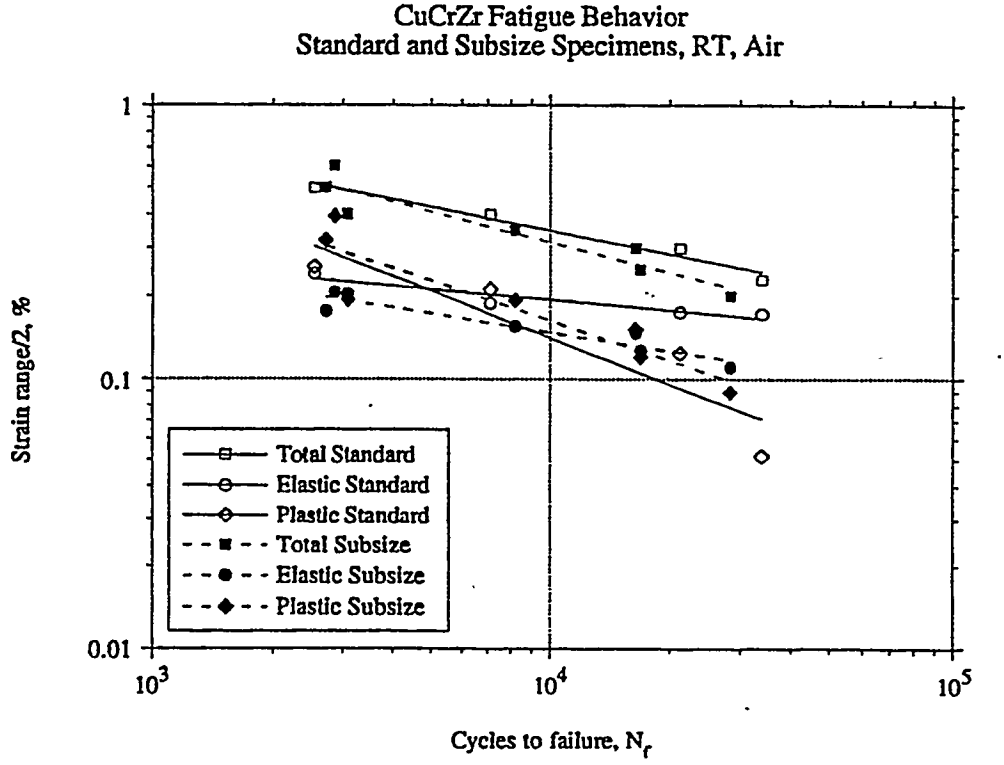

Figure 3. Comparison of the fatigue response of both standard size and subsize CuCrZr specimens