

## DISCUSSION

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A. L. Bement<sup>1</sup>—The thermal treatments giving rise to changes in grain size (alpha annealing and beta heat treatment) also cause texture rotation and the redistribution of compositional constituents. Have you eliminated the possible influences of these variables on your grain size correlation of mechanical properties?

D. G. Hardy (*author's closure*)—The textural differences between the alpha annealed and the beta heat-treated conditions were not large enough to account for the differences in the mechanical properties.

Redistribution of the intermetallic precipitates was observed on beta heat treatment: instead of being randomly distributed as in the alpha annealed structure, they tended to precipitate along the alpha platelet boundaries within each prior beta grain. As reported by Holt<sup>2</sup> and Ökvist and Källström,<sup>3</sup> two different Widmanstätten morphologies have been observed in beta heat-treated Zircaloy depending on the concentration of particles insoluble in the beta phase: a "parallel plate" structure and a "basketweave" structure.

A. R. Daniel of the Canadian General Electric Co., Peterborough, Ontario, working under contract to AECL, found that, although there was a difference in the general level of the total circumferential elongation in the burst test between the two types of structure, in both cases the ductility was proportional to the prior beta grain size. All the specimens reported in this paper developed a basketweave structure. Extrapolating Daniel's TCE versus grain size curve for the basketweave structure to the alpha annealed grain size gives a TCE of 30 percent, approximately the same as the TCE of the alpha annealed specimens reported in Table 4. It therefore appears that the prior beta grain size has a similar effect on the burst properties as the alpha annealed grain size, provided the former has the basketweave structure.

<sup>1</sup> Battelle-Northwest, Richland, Wash. 99352.

<sup>2</sup> Holt, R. A., *Journal of Nuclear Materials*, JNUMA, Vol. 35, June 1970, p. 322.

<sup>3</sup> Ökvist, G. and Källström, K., *Journal of Nuclear Materials*, JNUMA, Vol. 35, June 1970, p. 316.