DISCUSSION

A. L. Bement[1]—The development of alpha and epsilon phases in austenitic stainless steel is of interest as a possible metallurgical approach for reducing radiation induced swelling. The volume percent of alpha phase formed per unit cold work should increase with decreasing temperature and with decreasing carbon content in order of 316, 304, and 304L stainless steels. Is it possible that the favorable fatigue resistance of 304L and chilled-swaged material can be attributed to either the presence of alpha phase prior to fatigue testing or the formation of alpha phase at the fatigue crack root during fatigue testing?

J. M. Beeston (authors' closure)—Phase transformations that can occur in the metastable austenitic steels of the 18-8 variety due to deformation and aging temperatures are of importance to the structure and properties of these steels. Although the question as to whether the α phase in 18-8 steels can be produced by quenching may be controversial,[2,3] its increased formation with percent cold work as some function of temperature appears to be established.[4] Mangonon and Thomas conclude that further thermal nucleation of α phase is achieved by aging up to 400 C but that softening occurs by aging at 500 C and above due to a decrease in percent α phase. The ϵ phase could not be detected above 400 C.

By X-ray diffraction of a specimen, cold-worked and irradiated at 450 C and fatigue tested at 400 C, we could see evidence of the α phase. X-ray line broadening of the $(111)\gamma$ peak due to irradiation obscured the $(110)\alpha$ peak so that the evidence is based on the $(211)\alpha$ and the $(200)\alpha$ peaks which have the next highest intensity. X-ray diffraction of a chill-swage-temper specimen at the same irradiation and test temperature yielded negative indications of α phase. It is noted that the CST specimens were given a final temper at 760 C before irradiation and testing to stabilize the structure which would remove the α phase. We showed that the beneficial effect of cold work and the chill-swage-temper treatment were about the same at 700 C and present in the 600 C tests. The cyclic hardening behavior at

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[2] Mangonon, P. L., Jr., and Thomas, Gareth, *Metallurgical Transactions*, MTGTB, Vol. 1, June 1970, pp. 1577–1588.
[3] Gullberg, R. and Lagneborg, R., *Transactions*, AIME, TAIMA, Vol. 236, Oct. 1966, pp. 1482–1485.
[4] Mangonon, P. L., Jr., and Thomas, Gareth, *Metallurgical Transactions*, MTGTB, Vol. 1, June 1970, pp. 1587–1594.

test temperatures of 500 C and above did not indicate significant strain hardening behavior, which could be attributed to the production of the higher strength α phase (see Fig. 18).

These observations appear to rule out the presence of α phase prior to fatigue testing or its formation at the crack root during fatigue testing as the principal agent producing the beneficial effect. This is an interesting subject and needs further attention to determine the nature of the defect-substructure interaction which produces the higher fatigue life.