Summary

As was indicated in the Introduction, and as is evident in the body of papers contained in this ASTM Special Technical Publication, a large variety of small-specimen techniques has been under development; and these offer an opportunity to extract a wide range of mechanical properties. Certainly, not all of the investigators involved in small-specimen research were able to contribute to this publication; however, the papers herein are representative of the types of progress being made.

Development efforts to date appear to fall roughly into two categories: (1) those which are based on a miniaturization or scaling down of what might be termed "conventional" test specimens, and (2) those which are based on novel, unconventional techniques. The first category includes such techniques as miniature tensile, fatigue, fatigue crack growth, impact, and fracture toughness tests. Corresponding specimens currently have a wide range of volumes, from the crack arrest toughness specimens (~ 25 cm^3) reported by Marshall et al down to the small wire tensile specimens (~ 1 mm^3) reported by Bradley and Jones. These specimens are all, of course, small relative to their conventional counterparts. The second category of tests, such as disk bend, punch, and ball microhardness, is largely directed towards extracting properties from transmission electron microscopy (TEM) disks or TEM disk-sized specimens (~ 1.7 mm^3). Many of the tests in both categories have already been applied to extract useful qualitative or quantitative mechanical property data from irradiated specimens, but further miniaturization and/or development may be warranted in individual cases. Moreover, a number of tests provide similar kinds of data (e.g., strength or ductility parameters) using considerably different approaches. As these tests mature, however, it is likely that natural selection processes will result in the consolidation and elimination of complementary and duplicative techniques, respectively.

Not surprisingly, current small-specimen techniques address most of the properties considered of major interest for fusion reactor materials development. A number of extensions could be made using existing or slight modifications of existing techniques to obtain additional properties of interest, such as multiaxial ductility parameters or threshold fatigue crack propagation. This remains a goal for future research. In addition, there still appear to be opportunities for developing new test techniques to extract properties which are not currently being addressed; for instance, small-scale environmentally assisted cracking test specimens may be quite useful. Another area requiring further attention is technique automation, since alloy development programs ultimately will, and do, require rapid testing of large numbers of specimens.

Nonetheless, major inroads have been made in small-specimen testing. Existing techniques have very promising applications not only in developing materials for fusion reactors, but in numerous situations in both nuclear and non-nuclear systems where constraints require the extraction of mechanical properties from small-volume specimens.

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