Summary

The various aspects of the interdisciplinary engineering science of fracture mechanics, including engineering mechanics, sophisticated laboratory testing, metallurgy, and practical engineering have all taken their turns in the limelight of research attention. All these areas are essential to fracture mechanics, and all are represented in this book.

Given this opportunity to emphasize a few key points of this symposium, we choose to highlight the papers on the ductile-to-brittle transition and the related areas of elastic-plastic fracture mechanics and J-integral test methods (noting that the standard J-integral methods available to date are not applicable to cleavage fracture). Fracture mechanics as an engineering science has been strongly influenced by the practical need to understand and overcome the dramatic ductile-to-brittle transition behavior of ferritic steels with decreasing temperatures. Other problems have been important, especially crack growth by fatigue and the need to use safely high-strength materials such as certain aluminum and titanium alloys and steels. But the ductile-to-brittle transition still poses a first order challenge to fracture mechanics, to penetrate the scatter in the test results in order to arrive at a correct and useful description of material fracture properties within the transition range. Heavy-section structures for exploiting petroleum resources in the arctic are a current application area in need of progress in the ductile to brittle transition. This volume samples the inventory of the physical understanding, elastic and elastic-plastic analysis methods, and elastic-plastic test methods accumulated by fracture mechanics.

In particular, the paper by Wellman, Sorem, Dodds, and Rolfe showed that the relative size of the highly constrained region ahead of a crack is only weakly dependent on the specimen thickness. This adds weight to the weak-link statistical approach to cleavage fracture. Tyson's paper on cleavage toughness variability makes a strong case for a specific weak-link theory relating toughness variability to the inclusion size distribution.

The ductile-to-brittle transition occurs under elastic-plastic conditions, so all the papers on elastic-plastic fracture mechanics contribute to its understanding. The J-integral and crack opening displacement test methods will continue to become more useful in this region.

Fatigue crack growth remains an important problem in high-performance components, and this symposium reflects the importance of this subject area. Progress continues in the understanding of the growth of very small fatigue cracks and frequency and hold-time effects on fatigue at high temperatures.

Analysis methods continue to improve in scope, and re-examination of existing fracture criteria continues to deepen our understanding. Other important areas emphasized in this proceedings are micromechanisms, crack arrest, and subcritical crack growth.

This Special Technical Publication extends to one ultimate goal of fracture mechanics, practical applications. Several distinct methods are sampled here, indicating the variety of possibilities available and leading toward more powerful and more universal methods.

On behalf of the organizing committee of this Symposium, the editors thank the authors of their papers for their contributions, the chairmen of the sixteen sessions for their services in facilitating orderly discussion, and all one hundred thirty-seven attendees for their discussions.

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