Iowa State University

Materials Science & Engineering Department

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Final Oral Examination
PhD Student with Scott Beckman

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"A quantitatively accurate theory of stable crack growth in single phase ductile metal alloys under the influence of cyclic loading"

Although fatigue has been a well studied phenomenon over the past century and a half, there has yet to be found a quantitative link between fatigue crack growth rates and materials properties. This work serves to establish that link, in the case of well behaved, single phase, ductile metals. The primary mechanisms of fatigue crack growth are identified in general terms, followed by a description of the dependence of the stress intensity factor range on those mechanisms. A method is presented for calculating the crack growth rate for an ideal, linear elastic, non-brittle material, which is assumed to be similar to the crack growth rate for a real material at very small crack growth rate values. The threshold stress intensity factor is discussed as a consequence of "crack tip healing". Residual stresses are accounted for in the form of an approximated residual stress intensity factor. The results of these calculations are compared to data available in the literature. It is concluded that this work presents a new way to consider crack growth with respect to cyclic loading which is quantitatively accurate, and introduces a new way to consider fracture mechanics with respect to the relatively small, cyclic loads, normally associated with fatigue.