New testing procedure to determine da/dN- ΔK curves at different, constant R-values applied on ductile metallic materials

1. Tesch[1*], J. Schneider[2], R. Pippan[3]

[1] European Space Agency ESA, Materials Technology Section,

P.O. Box 299, NL-2200AG Noordwijk, The Netherlands

[2] German Aerospace Center, Institute of Materials Research, Linder Höhe

D-51147 Köln, Germany

[3] Austrian Academy of Sciences, Erich Schmid Institute of Materials Science,

Jahnstrasse 12, 8700 Leoben, Austria

[*] andreas.tesch@esa.int

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Introduction

A new concept for fatigue crack propagation tests, developed in [1], was applied on MUMETAL, a ductile material used in space application mainly as a shielding to protect electrical components from stray magnetic fields. In latest ESA projects it is also subjected to structural loading and therefore Fracture Mechanical parameters and the Fatigue Crack Growth have been characterised. With this concept it is possible to gain fatigue crack growth curves (da/dN- ΔK) for every R-ratio between R=0,9 and R= -1 with one single specimen. The basis of the concept is a line-up of step wise increasing K_{max}-constant tests. These tests were developed to get threshold values for the stress intensity range ΔK at high stress ratios R and without load history effects. The results of the new method are da/dN-ΔK curves with R-values covering the whole fatigue region from R= -1 to R=0,9. These curves can be translated into a diagram da/dN vs. R, from which one can generate da/dN- ΔK curves with constant stress ratio R at every R-value. The da/dN-ΔK curves generated from the K_{max} constant tests fit very well to the da/dN-ΔK curves generated with different specimens, according to the procedures described in the ASTM E 647.

Advantages of the new procedure are:

1. No load history effects due to plasticity induced crack closure. → It is possible to use higher ΔK decreasing rates compared to threshold test after ASTM. → time reduction
2. Determination of fatigue crack growth curves at a lot of different stress ratios R with one single specimen.
3. Determination of the thresholds of the stress intensity range ΔK_{th} as a function of R.
4. Little personnel expenditure and time. → cost reduction

The influence of welding and annealing the MUMETAL on the Fatigue Crack Growth will also be shown as well as the influence of the specimen thickness on the fracture toughness evaluation.

[1] New testing procedure to determine da/dN–ΔK curves at different, constant R-values using one single specimen; A. Tesch, R. Pippan, H. Döker; International Journal of Fatigue; Volume 29; Issue 7; July 2007; Pages 1220-1228