ABNORMAL FRACTURE IN TITANIUM ALLOY TA6V

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ABSTRACT

In the literature, many studies focus on abnormal phenomenon of fracture in titanium alloys. These kind of phenomenon is usually in the scope of ‘sustained load cracking’ or ‘fatigue crack propagation threshold’. The first one is a delayed cracking after subcritical loading on notched specimen [1] whereas the second one is known as “Marci effect” [2] which is the disappearance of fatigue threshold at very high \(K_{\text{max}}\) level. The clear connection between the two phenomenon is still an open debate but seems to be influenced by interstitials (O, C, N) and Hydrogen shielding [3]. These two points are also related to dynamic strain ageing (DSA) caused by interstitials hardening and room temperature creep enhanced by Hydrogen shielding. Sustained load cracking and fatigue crack propagation threshold are addressed in this paper on a titanium alloy TA6V.

**Keywords:** Sustained load Cracking, titanium TA6V, abnormal fracture.

EXPERIMENTAL EVIDENCES

Fatigue crack propagation tests were conducted on Compact Tension specimen of 12,5 mm thick. Three constant \(K_{\text{max}}\) loading regimen were applied showing the fatigue crack propagation threshold disappearance for high value close to \(K_{\text{lc}}\) (between 45% and 95% in figure 1).

![Fig. 1 - Fatigue crack propagation threshold disappearance for high \(K_{\text{max}}\) value (Crack growth rate versus Stress intensity factor range in log-log scale)](image-url)

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Other tests should be addressed to precise the exact value of the starting phenomenon.

**Sustained load cracking**

A different methodology was used in these tests involving KAHN specimen of 3 mm thick [4] rather than Compact Tension. Loading was sustained for half an hour steps starting from about 65% of maximum loading force to 80%. The phenomenon is clearly visible on figure 2.

![Diagram of KAHN specimen with dimensions](a)

![Graph showing sustained load cracking test](b)

Fig 2 - Sustained Load Cracking test (clip gauge displacement versus time) (b) on KAHN specimen (a)
RESULTS AND CONCLUSIONS

A specific evolution of drag stress in the viscosity function [5] is trying to represent interstitials hardening. In this way, specific time dependency is introduced aiming to represent delayed cracking with sustained load. Actually, only monotonic crack growth test is conducted showing viscous stress relaxation in front of the crack tip (figure 3).

![Finite Element Simulation of KAHN specimen under monotonic loading: von-Mises stress (a) and viscous stress (b) at the crack tip (in MPa)](image)

Fig. 3 - Finite Element Simulation of KAHN specimen under monotonic loading: von-Mises stress (a) and viscous stress (b) at the crack tip (in MPa)

REFERENCES


