TEMPERATURE-DEPENDENT FRACTURE PROPERTIES OF A Ti-5Al-2.5Sn ELI ALLOY

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Summary

In this communication results are presented of an experimental and computational study carried out on a Ti-5Al-2.5Sn ELI alloy in order to characterise its fracture behaviour at cryogenic (8 K and 77 K) and room (293 K) temperatures. Fracture tests, according to the prescriptions of ASTM Standards [1], on pre-cracked Compact Tension specimens (without side-grooves) have led to the following conclusions.

At 8 K the behaviour of the material considered can be depicted as elastic-brittle and described by a linear-elastic constitutive law up to failure. The fracture behaviour can be characterised in the framework of linear elastic fracture mechanics by means of mode I critical Stress Intensity Factor (K_{IC} =52 (MPa $m^{1/2}$)).

At 77 K the specimens show negligible nonlinearities in all plots load versus load-point displacement. Fracture toughness has been measured also in this case and amounts to mode I critical SIF $K_{IC} \cong 60$ (MPa $m^{1/2}$).

At 293 K a fracture process zone shows up straight ahead of the crack tip. In this case fracture toughness has been quantified by means of a J-resistance graph.

In the third case numerical simulations of the onset of crack propagation have been performed: in order to allow for the effects of plastic dissipations in the fracture process zone a Gurson's type constitutive model has been adopted together with the computational cell concept [2]. Experimental and computational results agree fairly well as for the global behaviour of the specimen, namely in terms of load versus load-point displacement relationship. On the other hand, further improvements of the simulation techniques should be adopted in order to achieve better agreement in terms of local strains in the fracture process zone.

This study has been conducted for the cryogenic materials to be employed in the future particle detector ATLAS in Geneva; the tests have been carried out in the LASA laboratory of INFN in Segrate.

References

[1] ASTM E 1820. " Standard Test Method for Measurement of Fracture Toughness". American Society for Testing and Materials, **1996**

[2] Xia, L., Shih, C.F. and Hutchinson, J. W. "*A computational approach to ductile crack growth under large scale yielding conditions*". Journal of the Mechanics and Physics of Solids, **43**, 389-413, **1995**.