MECHANICAL BEHAVIOUR OF TiAl ALLOYS DURING STATIC AND DYNAMIC DEFORMATIONS

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Mechanical behavior of materials (TiAl intermetallics) applied in airplanes, helicopters and power generators subjected to compression in the range of the strain rates (10^{-4} s^{-1} ÷ 10^{4} s^{-1}) have been investigated.

Three different TiAl alloys have been studied:

1. composition: Ti-48Al-2Cr-2 Nb - Insamet
2. composition: Ti-43Al-0.8Mo-0.8Cu-0.2 - Pol. Śl.
3. composition: Ti-6Al-4V - Stepino Titanium Company Ltd.

The stress-strain characteristics of high accuracy have been obtained in quasi-static test conducted on TiAl specimens (5 mm diameter, 5 mm height) mounted to the Instron testing machine. In order to acquire true values of mechanical parameters the laser externsometer was applied. It ensured determination of real values of strains and mechanical parameters. The smart extensometer technique enables to measure deformation of speciemens directly and independently from the testing machine and the grip interaction. All experiments have been carried out at room temperature. Three tests have been done for each rate of deformation value.

Dynamic investigations were carried out on Hopkinson pressure bar apparatus, available in IPPT, according to the technique presented in [1, 2].

In each test we obtained strain-stress characteristics as well as values of Young's modulus and yield stress.

The examples of the stress-strain relations obtained during uniaxial quasi-static compression of the TiAl material, for the selected rates of deformation, are presented in the Fig. 1.

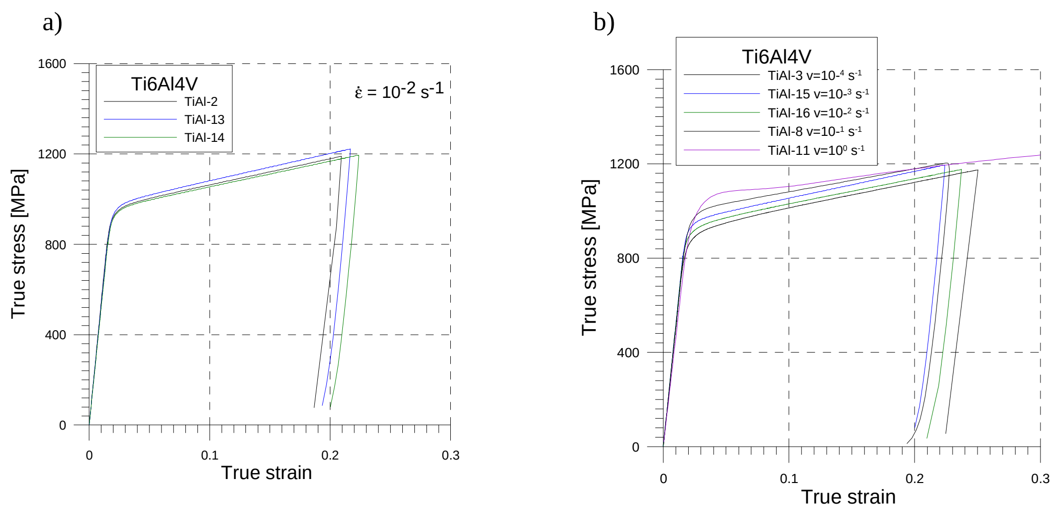

Fig. 1. Stress-strain relations obtained during quasi-static compression tests of the TiAl intermetallic: a) for the same rate of deformation, b) for different rates of deformation

The mechanical characteristics recorded for the compression tests of Ti-6Al-4V intermetallic (Fig. 1a), have pointed that the differences between results obtained for the same rate of deformation are not significant. The results presented in the Fig. 1b have shown that for higher strain rate, the higher strain hardening is observed. Moreover, in the case of the highest strain rate being applied, namely 1 s^{-1}, the stress-strain relation has manifested a dynamic character. In the Fig. 2 examples of the same relations obtained for dynamic rates of deformation are presented.

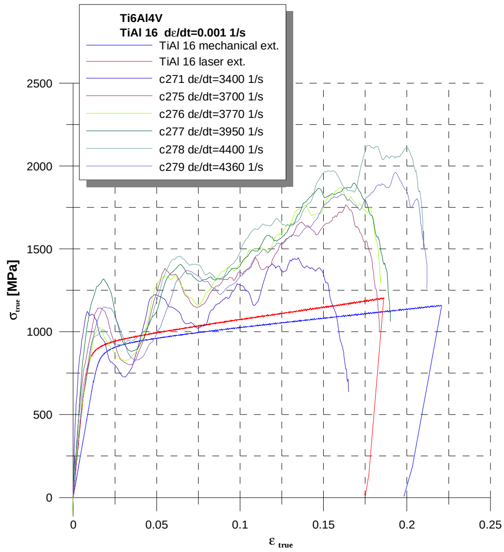

Fig. 2. Stress-strain relations obtained for dynamic compression tests of TiAl itermatallic, performed with the strain rates from the range 3400 s^{-1} - 4400 s^{-1}, and the example of quasi-static ones obtained using the mechanical and laser extensometers

The stresses recorded in the dynamic tests are higher than those observed in static tests. In the elastic range of deformation the results obtained for the dynamic rates of deformation and as well as the quasi-static ones (acquired by the laser extensometer) are comparable.

References

[1] E.A. Pieczyska, R.B. Pęcherski, S.P. Gadaj, W.K. Nowacki, Z. Nowak, M. Matyjewski, Experimental and theoretical investigations of glass fibre reinforced composite subjected to uniaxial compression for a wide spectrum of strain rates, *Arch. Mech.* ***58**, 3, 2006, pp. 273-291.*

[2] W.K. Nowacki, S.P. Gadaj, J. Luckner, Report KMM-NoE, II Part, Project TR 1.1 „*Titanium aluminates for high temperature applications”*, 2007.