MULTISCALE FRACTURE MODEL FOR QUASI-BRITTLE MATERIALS

Morozov N.F., Bratov V.A., Petrov Y.V.

St. Petersburg State University, St. Petersburg, Russia, morozov@nm1016.spb.edu

Fracture of quasi-brittle heterogeneous materials is steered by processes at several different scale levels. These processes can progress independently or affect each other. In order to model fracture of such materials one should account for all rupture processes contributing to overall fracture process. This report is the summation of our knowledge and experience in experimental, theoretical and numerical investigations of multiscale nature of brittle fracture. Model accounting for fracture scale level will be presented. The model will be applied to predict fracture of quasi-brittle heterogeneous materials on different scale levels. It will be shown that this can give a possibility to predict fracture on a higher (real) scale level having experimental data obtained on a lower (laboratory) scale. This possibility is of extreme importance for many applications where the possibility to evaluate material strength properties on real structure scale level does not exist (ex. trunk pipelines, geological objects, big concrete structures, etc.).

STRUCTURE-SCALE LEVELS NON-ELASTIC MARTENSITE DEFORMATION UNDER ISOTHERMAL LOADING OF SUBMICROCRISTALLINE ALLOY $Ti_{49,4}Ni_{50,6}$ IN PRE-MARTENSITE STATE

Bakach G.P.[1], Dudarev E.F.[2], Skosyrskii A.B.[1], Maletkina T.Yu.[2]

[1]*National Research Tomsk State University, Tomsk, Russia*
[2]*Tomsk State University of Architecture and Building, Tomsk, Russia, tabachenko@spti.tsu.ru*

$Ti_{49,4}Ni_{50,6}$ alloy with submicrocristalline structure, formed by intensive plastic deformation at increased temperature, as alloy with coarse-grained structure, are characterized by polycrystalline grain-subgrain structure and, from beginning of loading, non-uniformity of intensive state on level individual grain. In accordance with available theoretical calculations, there is difference between stress state of grains on the surface or in the volume of specimen: more high stresses act at boundaries grains on the specimen surface and less high stresses act at grains in specimen volume. In consequence of this coarse-grained and submicrocristalline $Ti_{49,4}Ni_{50,6}$ alloy in pre-martensite state under isothermal loading, martensite transformation must to begin in grains on the surface of specimen with subsequent forming mezzo-bands localization of martensite transformation under tension concentration in neighboring grains.

The experimental investigations of martensite transformation by method of optical metallography in situ at tension deformation of submicrocristalline alloy $Ti_{49,4}Ni_{50,6}$ confirmed predicted two-stage development of in-elastic martensite deformation at the initial stage of loading. In the first stage of deformation localization mezzo-bands of martensite deformation of two orientations first of all grow up in length. In the end of this stage it formers macro-band of martensite transformation with front under exemplary 60° to axis of tension. On second stage front of macro-band moves, but first of all martensite transformation develops in a form mezzo-bands. With this the value of non-elastic martensite deformation in the macro-band on stage of his spreading keeps invariable and equal to deformation of specimen in the end of second stage. However martensite transformation in macro-band is not complete and it concludes on third stage of deformation.

Accordance between structural-scale localization level of martensite transformation and deformation behaviour of submicrocristalline and coarse-grained alloy $Ti_{49,4}Ni_{50,6}$ at isothermal loading was established. It was showed the similarity of deformation behaviour on the initial stages of martensite transformation and plastic deformation at isothermal loading submicrocristalline alloys. Physical nature of this similarity was substantiated.

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HIGH-STRENGTH SUBMICROCRYSTALLINE TITANIUM ALLOYS WITH A NANOCOMPOSITE ANTIFRICTION COATING

Potekaev A.I., Tabachenko A.N., Savostikov V.M., Dudarev E.F.

[1]*National Research Tomsk State University, Tomsk, Russia,*
tabachenko@spti.tsu.ru

High specific strength at high ductility, heat resistance and corrosion stability in various corrosive medium are typical for α – and (α+β) – titanium alloys. That is why they are extensively applied in aviation and aerospace engineering, shipbuilding and chemical industry. At the same time they exhibit high friction coefficient and low wear resistance which make their application for kinematic and tribotechnical coupling unfeasible.

In order to simultaneously increase the strength and significantly improve the mechanical and tribotechnical properties of titanium and (α+β) – titanium