ACEX2021

14th International Conference on Advanced Computational Engineering and Experimenting
04 - 08 July, 2021 / MALTA

Description of quasi-static and dynamic damage processes in 2-phase ceramic matrix and metal matrix composites reinforced by ceramic grains*)

Tomasz Sadowski[1], Eligiusz Postek[4], Daniel Pietras[1], Marek Boniecki[2], Magdalena Szutkowska[3]
t.sadowski@pollub.pl

[1]Department of Solid Mechanics, Lublin University of Technology, 20-618 Lublin, Poland
[2]Institute of Electronic Materials Technology, 01-919 Warsaw, Poland
[3]Institute of Advanced Manufacturing Technology, 30-011 Cracow, Poland
[4]Institute of Fundamental Technological Research, Polish Academy of Sciences, 02-106 Warsaw, Poland

Quasi-static degradation of brittle composites exhibits different mechanical response under uniaxial tension and uniaxial compression. In this paper we analysed cracking processes and failure under quasi-static loading of 2 phase ceramic material made of alumina and zirconia mixture, subjected to tension and compression. Constitutive modelling of two phase ceramic composites obeys description of: (1) elastic deformations of initially porous material, (2) limited plasticity and (3) cracks initiation and propagation.

Modelling of polycrystalline ceramics at mesoscopic level under mechanical loading is related to analysis of a set of grains, which create so called Representative Volume Element (RVE). The basic elements of the defect structure inside polycrystal are: micro- and meso-cracks, kinked and wing cracks. To get macroscopic response of the material one can calculate averaged values of stress and strain over the RSE with application of analytical approach.

Dynamic degradation process was illustrated for 2 phase ceramic matix composite and cermet, which was subjected to short compressive impulse. The pulse duration was 10^{-7}s and the applied pressure level - 480 MPa. In the proposed more advanced finite elements formulation of the cermet behaviour is was necessary to take into account the following data and phenomena revealing inside of the RVE: (1) spatial distribution of the cermet constituents, (2) system of grain boundaries/binder interfaces modelled by interface elemnets, (3) rotation of brittle grains. The cermet response due to pulse loading is significantly different in comparison to the quasi-static behaviour, i.e. the stress distributions and microcracking processes are quite different.

Keywords: *ceramic matrix composites, cermet, quasi-static degradation, dynamic degradation, analytic model, numerical model.*

*) This paper is devoted to prof. J.N.Reddy on occasion of his 75th BIRTHDAY.

Acknowledgment

The results presented in this paper were obtained within the framework of research grant No. UMO/2016/21/B/ST8/01027 financed by the National Science Centre, Poland