13th National Congress on Theoretical and Applied Mechanics, Sofia, Bulgaria, 6-10.09.2017

http://nctam.imbm.bas.bg/index.php/nctam/13nctam/paper/view/738

Micro-CT based numerical modeling of residual stresses and fracture in metal-ceramic composites

Michał Basista

In metal-ceramic composites fabricated by powder metallurgy or metal infiltration techniques thermal residual stresses (TRS) that arise inside the composite during the cooling phase pose a real technological problem as they may lead to an unpredictable cracking of a structural component. While the manufacture processes have been significantly improved and new materials solutions like graded composite structures (FGM) have been proposed to reduce the TRS, much support in tackling this problem can be offered by modeling capable of predicting residual stresses in metal and ceramic phases of the composite.

This paper presents an approach to TRS modeling that incorporates real microstructure images obtained from X-ray micro- computed tomography instead of making assumptions on the composite morphology like in micromechanics. It shows how the FE mesh can be created from micro-CT data and discusses limitations of this procedure. The method is applied to predict residual stresses in ceramic and metal phases of several types of composites with different microstructure: hot pressed Cr/Al_2O_3 and $NiAl/Al_2O_3$ particulate composites, interpenetrating phase composite AlSi12/ Al_2O_3 made of porous alumina ceramic preform infiltrated with molten aluminum alloy. The results of numerical simulations of TRS are confronted with the experimental data from neutron diffraction measurements done at the European facilities (neutron sources). In addition to the TRS model the micro-CT based FEM is used to compute fracture parameters for the infiltrated metal-ceramic composites, which exhibit complex irregular microstructure.