Numerical modeling of thermal residual stress in $NiAl/Al_2O_3$ composites: Effect on mechanical properties

W. Węglewski, M. Basista, K. Bochenek

Institute of Fundamental Technological Research Warsaw, Poland

Abstract:
In this paper a numerical model will be presented to investigate the influence of processing-induced thermal residual stresses (TRS) on the mechanical properties (E modulus, bending strength) in particulate bulk intermetallic-ceramic composites. The materials under consideration are hot pressed $NiAl/20\%Al_2O_3$ bulk composites sintered in different temperatures (1300 C deg. and 1400 C deg.).

The reported research includes the processing of composites by powder metallurgy techniques (HP), microscopic analysis of material microstructure with special focus on micro-CT scanning, measurements of TRS by neutron diffraction (ND) method and numerical modeling of TRS by FEM based on micro-CT images of real material microstructure.

Numerical micro-CT based models are proposed to predict the TRS and Young's modulus with account of the TRS-induced damage of the ceramic phase. Our micro-CT based FEM models reproduce the TRS measurements with a good accuracy which may be an asset in applications having in mind the high cost of beam time for ND experiments at neutron sources. Finally, the experimental data and modeling results are compared to assess the TRS/microstructure effect on the Young's modulus of the composites investigated.