THE INFLUENCE OF MICROSTRUCTURE ON THERMAL RESIDUAL STRESS AND FRACTURE TOUGHNESS OF NICKEL ALUMINIDE-ALUMINA COMPOSITES – EXPERIMENT AND NUMERICAL MODEL

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Keywords: Thermal Residual Stress, Neutron Diffraction, Metal Matrix Composite, Numerical Modelling

The NiAl–intermetallic based composites are potentially very attractive structural materials for aerospace and automotive applications due to high corrosion resistance, low specific weight and good strength properties at high temperatures. However, the brittleness of NiAl limits its today’s industrial use. In recent years a revival of research on improvement of NiAl toughness is observed and many technological approaches were proposed [1].

The purpose of this paper is to explore the effect of alumina ceramic addition to NiAl using powder metallurgy route and to examine experimentally and numerically the effect of microstructure on the fracture toughness of NiAl/Al₂O₃ composite with processing-induced thermal residual stresses (TRS) being an additional factor taken into account. Powder mixtures with 30, 60 and 90 vol. % of Al₂O₃ and different NiAl particle size (5 vs. 45 microns) were sintered by hot pressing. In the FEM model of TRS real microstructure images from micro-CT were incorporated using the methodology developed in [2], (Fig. 1). The numerical results of TRS were compared with measurements by neutron diffraction method. The fracture toughness was determined in SEVNB test in four point bending.

![Fig. 1. MicroCT image of NiAl/Al₂O₃ composite (a), FE mesh (b) computed residual stresses for alumina (c) and NiAl (d) phase.](image)

The scientific objective of this study, i.e. experimental exploration and predictive modelling of the influence of microstructure on the TRS and \( K_{IC} \) was achieved and the obtained results clearly confirm this effect.

Acknowledgment

This research was supported by Polish National Science Centre grant, Influence of Thermal Residual Stresses on Fracture Behaviour and Selected Mechanical Properties of Metal-Ceramic Composites: Experiments and Modeling (UMO-2014/15/B/ST8/04314).

References
