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

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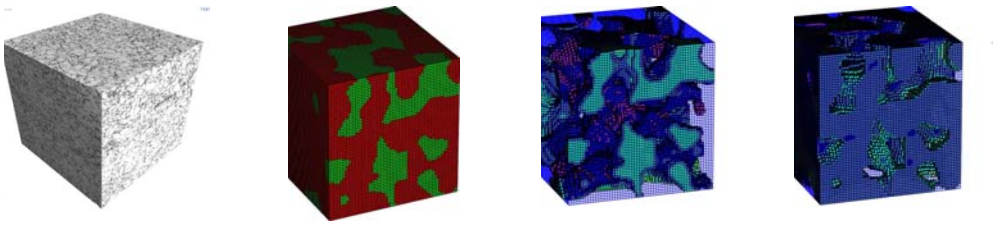
The NiAl–intermetallic based composites are potentially very attractive structural materials for aerospace and automotive applications due to high corrosion resistance, low specific weight and good strength properties at high temperatures However, the brittleness of NiAl limits its today's industrial 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/$Al_2O_3$ composite with processing-induced thermal residual stresses (TRS) being and additional factor taken into account. Powder mixtures with 30, 60 and 90 vol. % of $Al_2O_3$ 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.



a) b) c) d)

Fig. 1. MicroCT image of NiAl/$Al_2O_3$ composite (a), FE mesh (b) computed residual stresses for alumina (c) and NiAl (d) phase.

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.

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**References**

1. K. Bochenek, M. Basista, "Advances in processing of NiAl intermetallic alloys and composites for high temperature aerospace applications" *Progress in Aerospace Sciences*, pp.136-146, 2015

2. M. Basista, W. Węglewski, K. Bochenek, Z. Poniżnik, Z. Nowak, "Micro-CT Finite Element Analysis of Thermal Residual Stresses and Fracture in Metal-Ceramic Composites", *Advanced Engineering Materia*ls, 2017 (DOI: 10.1002/adem.201600725).