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Effect of microstructure on mechanical properties and residual stresses in interpenetrating aluminum-alumina composites fabricated by squeeze casting

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Aluminum-alumina composites with interpenetrating network structure are interesting structural materials due to their high resistance to elevated temperature and frictional wear, good heat conductivity, enhanced mechanical strength and fracture toughness. In this paper aluminum-alumina bulk composites and FGMs are manufactured by pressure infiltration of porous alumina preforms with molten aluminum alloy (EN AC-44200).
The influence of the interpenetrating microstructure on the macroscopic bending strength, fracture toughness, hardness and heat conduction is examined. Special focus is on processing-induced thermal residual stresses in aluminum-alumina composites due to their potentially detrimental effects on material performance in structural elements under in-service conditions. The residual stresses are measured experimentally in the ceramic phase by neutron diffraction and simulated numerically using a micro-CT based Finite Element model, which takes into account the actual interpenetrating microstructure of the composite. The model predictions for two different volume fractions of alumina agree fairly well with the neutron diffraction measurements.

[1] J.Maj, M.Basista, W.Węglewski, K.Bochenek, A.Strojny-Nędza,
K.Naplocha, T.Panzner, M.Tatarková, F.Fiori, Mat. Sci. Engng. A 715 (2018) 154–162

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