Fatima Nisar[1)], Szymon Nosewicz[1)], Kamil Kaszyca[2)], Marcin Chmielewski[2)], Jerzy Rojek[1)]

[1)] Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland

[2)] Łukasiewicz - Institute of Microelectronics and Photonics, Warsaw, Poland

Discrete element simulation of heat flow in porous materials manufactured by FAST/SPS

Abstract

Numerical modelling of heat conduction in porous materials manufactured by FAST/SPS using the discrete element method (DEM) will be presented. FAST/SPS techniques belong to a broad class of electrical-current activated sintering technologies. Microstructure of sintered porous materials is represented with spherical particles (discrete elements) connected with necks.

The discrete element method for heat conduction analysis developed is based on the thermal pipe-network approach. It employs lumped capacitances concentrated at the centres of the particles which are connected by heat-conducting bars (thermal pipes). The governing equations are based on the balance of the rate of heat-storing in the lumped capacitances and rate of heat flow through the pipes, and any other contributions of heat transfer. The effective thermal conductance of the pipe has been determined using the analytical approximation.

The DEM is applied to the simulation of transient heat flow in cylindrical samples built from spherical particles representing powder particles at a different stage of sintering. The steady-state temperature field is used to determine the effective thermal conductivity from the Fourier law of heat conduction. Numerical results have been validated using own experimental results for NiAl and copper. Quite a good agreement between numerical and experimental results has been found.

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