The 9th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2024
3 – 7 June 2024, Lisbon, Portugal

# DEM MODEL FOR EFFECTIVE PROPERTIES IN ELECTRIC CURRENT ASSISTED POWDER SINTERING

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

[1]Institute of Fundamental Technological Research, Polish Academy of Sciences, 02-106 Warsaw, Poland, fnisar, jrojek, snosewicz@ippt.pan.pl, https://www.ippt.pan.pl/en/

[2] Lukasiewicz Institute of Microelectronics and Photonics, 02-668, Warsaw, Poland, marcin.chmielewski, kamil.kaszyca@imif.lukasiewicz.gov.pl, https://imif.lukasiewicz.gov.pl/en/

**Key Words:** *Discrete element method (DEM), Effective properties, Coupled multiphysics problem, Heterogeneous microstructure, Interface*

Recently, Electric Current Assisted Sintering (ECAS) has gained immense attraction due to its efficiency and novelty. It is a powder consolidation technique that employs electric current to generate heat (Joule effect) while simultaneously applying pressure to efficiently achieve densification. Multiphysics phenomena involving the interdependence of electrical, thermal and mechanical effects make the process complex. In this work, a coupled microscopic thermo-electric model is developed within discrete element framework. In the discrete element method (DEM), each particle is considered a discrete element, hence making it suitable to model granular materials. Herein, the DEM model for electrical and thermal conduction between particles employs the original conductance model presented in [1]. Additionally, the interfacial or grain boundary resistance due to porosity is also considered in the model. The model is implemented to simulate both electrical and thermal conduction in partially sintered porous materials with heterogeneous microstructures. The simulation results were used to calculate effective electrical and thermal conductivities of partially sintered porous samples. These properties can be used as input parameters in the FE macroscopic model of powder densification during sintering. The model was calibrated and validated using experimentally measured thermal and electrical conductivities of porous NiAl samples manufactured via ECAS [2].

## ACKNOWLEDGEMENT

Research funded by National Science Centre, Poland, project no. 2019/35/B/ST8/03158

## REFERENCES

[1] J. Rojek, R. Kasztelan, and R. Tharmaraj. Discrete element thermal conductance model for sintered particles. Powder Technology, 405:117521, 2022

[2] S. Nosewicz, G. Jurczak, T. Wejrzanowski, S.H. Ibrahim, A. Grabias, W. Węglewski, K. Kaszyca, J. Rojek, and M. Chmielewski. Thermal conductivity analysis of porous NiAl materials manufactured by spark plasma sintering: Experimental studies and modelling. International Journal of Heat and Mass Transfer, 194:123070, 2022.