Computational Analysis of Spark Plasma Sintering: Heat Transfer and Temperature Distribution

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Spark Plasma Sintering is a tool that offers a very effective and fast sintering process, however there are many unknowns on how this technology is so effective at sintering powders. Computational analysis of SPS shows promise to explain the different sintering processes that occur during SPS and will be able to serve as a functional tool to optimize and predict future SPS runs. In this study, the computational analysis of an SPS experiment is conducted utilizing the finite element analysis package COMSOL®. Meaningful data, such as relative density prediction, can be potentially obtained throughout the use of this technique. However it is required to proof the functionality and accuracy of the whole SPS system before inputting stress-strain sintering theories. Existing boundary conditions from a blank die experiment were implemented in order to apply transient boundary conditions on the FEA model and check for accurate output of temperature in the SPS die. Voltage and pressure were used as inputs to the system and a multiphysics joule heating model was set up in order to correlate both inputs and solve the differential equation systems, which leads to an accurate solution for the temperature distribution in the system. Electrical as well a thermal resistances were considered and their effect on the computational result is evaluated in order to estimate the overall consequences of the contact resistances in the temperature distribution of the graphite die.