Selective laser sintering (SLS) is an additive manufacturing technique for rapidly creating parts directly from a CAD model by using a laser to fuse successive layers of powder. However, careful selection of processing parameters is important to ensure high quality produced parts. Currently no technique exists to use new materials and designs without experimentation to determine optimum processing parameters. Continuum models of the process show promise in reducing experimentation by predicting the properties of SLS parts produced using given parameters, but they require bulk powder material properties such as effective thermal conductivity which are often not known. In this paper, we develop a model to determine this quantity computationally and, unlike in previous works, use it to examine the effects of finite bed depth and temperatures near the material melting point.

In this work, a Discrete Element Model (DEM) is developed and implemented in the open source solver MFiX. An empty domain is initialized and randomly filled with spherical particles falling under the influence of gravity. Two opposing walls of the domain are then set to a fixed temperature and resulting heat sources in all particles are calculated using models developed in previous works for particle-particle contact conduction, particle-fluid-particle conduction, and a view factor model for radiation. A non-linear solver is used to calculate the steady-state particle temperatures. Total heat flux from the walls is then calculated and effective thermal conductivity determined using Fourier's law. Results are compared against previous computational and experimental measurements for powder beds and good agreement is obtained. Results for effective thermal conductivity of finite sized beds and beds with a wide range of temperatures are obtained with quantified uncertainties. These results may be used in SLS continuum models to accurately characterize of thermal properties of finite-thickness beds and bed with temperatures near the material melting point.