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SEMINAR

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Fully coupled electro-thermal-mechanical finite element model for predicting solid-phase sintering kinetics

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This work presents a simple and practical finite element model for simulating solid phase sintering under electrical and thermal loading. The model is applied to a Spark Plasma Sintering setup made of graphite tools, graphite felt insulation, and a compact of Nd2Fe14B or stainless steel. The simulation first performs an electro thermal analysis, where applied voltage and isothermal holds generate Joule heating and create a temperature field inside the sample. These temperatures are then transferred step by step to a thermo mechanical model. Only one quarter of the setup is simulated, and symmetry conditions, gravity, and perfect bonding are used to reduce the computational cost.

The mechanical part of the model uses a Fortran subroutine that describes sintering through grain growth, viscous flow, porosity change, and sintering stress. The relative density evolves from the volumetric strain, which allows the model to follow how porosity decreases during the process. The model updates all important variables such as grain size, viscosity, sintering stress, creep rate, and densification rate throughout heating, holding, and cooling.

Overall, this coupled model predicts temperature, stress, deformation, and densification during the complete sintering cycle. It provides a useful tool for studying and optimizing Spark Plasma Sintering conditions and for understanding how materials densify under complex thermal histories.

Kindly invited.