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Reduced-Dimensional Coupled Electromagnetic, Thermal, and Mechanical Models of Microwave Sintering[1]

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In recent years, sintering of micro- and nanopowders carried out in microwave ovens has emerged as a manufacturing technique with many potential advantages over sintering in conventional ovens, including faster processing, finer microstructure, and—in well designed systems—the potential for vast energy savings. A number of techniques for modeling the physical phenomena involved have been reported, but still, there remain various aspects of this highly complex and strongly coupled sequence of events that warrant more careful treatment in mathematical models and their computer implementations. We review the most crucial of these aspects, including the multiscale nature of this problem both in time and in space, as well as the strong coupling of the multiphysics phenomena it involves, and we demonstrate ways of addressing these issues via a reduced-dimensional model of microwave sintering that simulates the electromagnetic, thermal, and macroscale mechanical problems, together with different types of auxiliary models that rectify the typical absence of experimental data on certain material parameters necessary for use in the macroscale solver by simulating their values, and we present a computational example in one dimension to showcase operation of the model.

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