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Thermomechanical modeling of L-PBF 3D printing

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In the recent years, additive manufacturing (3D printing) of metals has risen in popularity in industrial applications. It is attractive, because it provides the possibility to manufacture shapes not achievable by other methods, as well as offers operational flexibility and reduced production time. We investigate the thermomechanical behavior of 3D printing of metals in the laser-based powder bed fusion (L-PBF) process, also known as selective laser melting (SLM). Heat transport away from the printed object is a limiting factor. We construct a thermoviscoelastic continuum model for the case where a thin fin is being printed at a constant velocity. We use a coordinate frame that moves with the printing laser, and apply an Eulerian perspective to the moving solid. We consider a steady state similar to those used in the analysis of production processes in the process industry, in the field of research known as axially moving materials. We demonstrate the model with material parameters for 316L steel. Modeling of the fundamental phenomena leads to knowledge applicable, for example, to quality control of the printing process.