Thermodynamic multifield modeling of electromagnetic metal forming

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The purpose of this work is the formulation of a thermomechanical electromagnetic multifield model and its application to simulate electromagnetic sheet metal forming (EMF). In this process, the metal forming process is driven by the interaction of an electric current generated in the workpiece with a magnetic field generated by a coil adjacent to the workpiece. The interaction of these two fields results in a material body force know as Lorentz force. Up to now, modeling approaches found in literature for EMF are restricted to the axisymmetric case. For real industrial applications however, the modeling of 3-dimensional forming operations becomes crucial.

The presentation begins with the thermodynamic formulation of the basic model equations. This is carried out in the framework of both the Liu-Müller and Clausius-Duhem entropy-dissipation principles. The resulting reduced model relations form the basis for the formulation of the initial boundary-value problem for electromagnetic metal forming. The algorithmic formulation and numerical solution of the corresponding initial boundary-value problem is based on Newton-Schur and staggered solution schemes. Applications will be presented and discussed.