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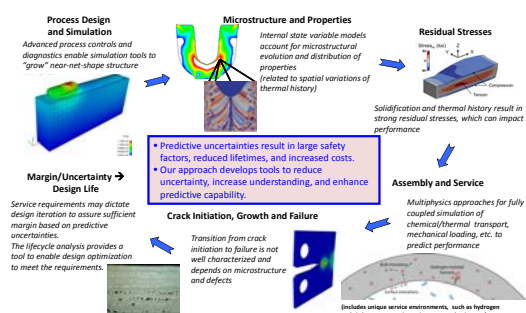# Process Modeling for Additive Manufacturing

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Research Objectives
- Develop the capability to predict residual stresses in AM products
- Extend high-fidelity material models to capture material evolution during the formation process, leading to prediction of end-state material properties
- Provide a basis for engineering tools to propose improvements to additve manufacturing process variables, including those that minimize process variation
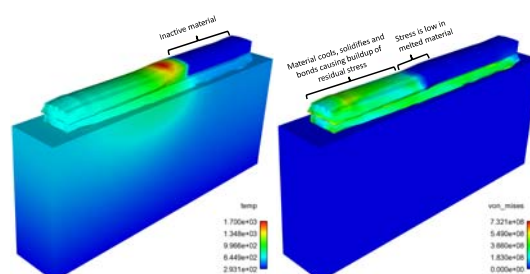
Introduction
- Residual stresses lead to distortion and cracking
- Previous work has been done to develop the ability to predict residual stress evolution
- Better understanding of lifecycle of AM components is needed

Problem Statement and Approach
- Develop computational simulation tools to model metal additive manufacturing process via integration with existing SNL software (SIERRA)
- Leverage our efforts with other SNL activities (including Josh Sugar's LDRD, UC Davis Campus Executive Fellowship, GTS support for development of additive manufacturing, new AM machines, etc.)

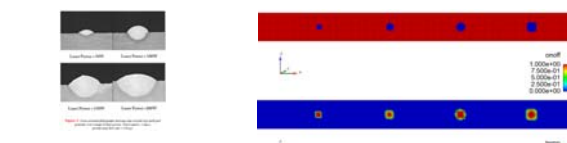Experimental data provided by Josh Sugar's LDRD to validate the models

Results
- New spherical, volumetric heat source based on raster path
- Element birth via "inactive" elements – variable conductivity based on heat source
- Phase transformation at melt temperature
- Contact transitions from Coulomb to glued (material melts then solidifies) to build up residual stresses
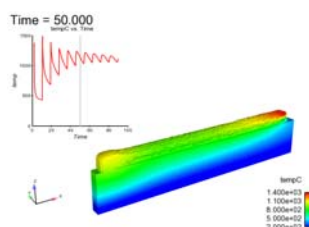

- Work is underway to implement active/inactive material (compliant and weightless) on the solid mechanics side
- Activation and melt pool size based on variable input power

Other Applications
- Gas tungsten arc (GTA) weld
- Electron beam
- Laser welding