NUMERICAL MODELING OF SELECTED ELECTROHEAT PROBLEMS

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Outline

- Motivation
- Calibration of Material Characteristics
- Problem of CCT Diagram and Fast Cooling
- Model of Keyhole Effect
- Additive Technique Models

Motivation

- Modelling is an increasingly powerful and usable tool
- With the development of optimization techniques and machine learning, new opportunities for device development are opening up
- Nonlinear coupled models are not optimization-friendly

Calibration of Material Characteristics

- Material parameters are big problem in area of numerical modeling
- Problems with nonlinear (temperature dependent) characteristics
- Material properties in liquid state
- Variations in material parameters of steels from different manufacturers
- Technique of automatic correction of material characteristics based on measurements using optimizations

Calibration of Material Characteristics











BOBYQA

Monte Carlo

Calibration of Material Characteristics



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Problem of CCT Diagram and Fast Cooling

- Prediction of the surface hardness
- Problems
 - High cooling rate
 - High temperatures
- Posibility to use calibrated numerical model
- Unknown values for calibration
 - Power delivered to surface
 - Heat transfer coefficient
 - Material parameters



Problem of CCT Diagram and Fast Cooling



Problem of CCT Diagram and Fast Cooling

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• For prediction of harness, we (GAH Maynier et al., based on the m H rate. The formula reads

$$HV_{M} = 127 + 949 \cdot C + 2^{-3}$$

- We got hardness $HV_M = 588$ F
- We (from H) = 1 and from H = 1 and
- When the measured was carri HV5 with of the average of three experiments provided the value of 572

Model of Keyhole Effect

- As a result of the capillary effect and evaporation of part of the material, the temperature flux penetrates to a greater depth
- Respecting this effect is important for further use of the model
- We've tried several techniques to respect that nonlinear boundary conditions, deformed geometry, material characteristics, CFD, optimization of boundary shape





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Model of Keyhole Effect



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LASER cladding

- Modern technology for improving the quality and physical parameters of steel surfaces.
- The main problem is the change of geometry during the process (in time).







We can use a combination of MATLAB and add small blocks to the geometry at each time step.



In the next step, the pattern was formed by gradual deformation of the geometry.



Last tested technique - the welded area and the shape of the pattern are formed by matrices that define the geometric area.



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Thank you for your kind attention

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