



Fall Series 2021  
Modeling and Simulation  
16 Nov 2021



INSPIRE



CONNECT



DISCUSS



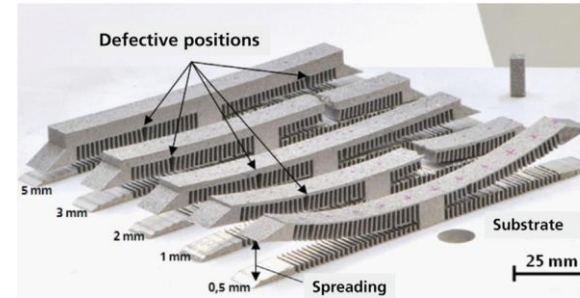
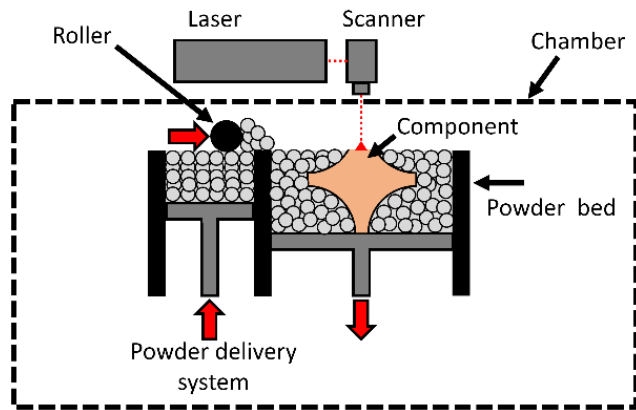
IGNITE

# Part-scale simulation of residual stress and distortion in LPBF process

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# Laser Powder Bed Fusion Process



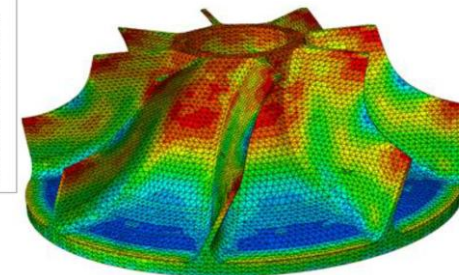
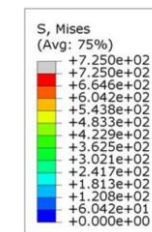
Li et al. (2017)



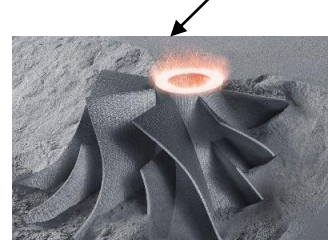
Parry et al. (2016)

## Thermomechanical simulations:

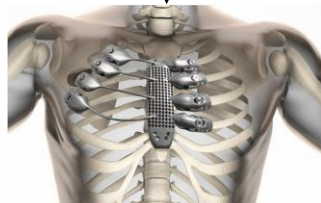
- Deeper & quantitative understanding of LPBF process
- More systematic optimisation of process parameters
- Drive the goal of «first-time-right» high quality production



Yaghi et al. (2017)



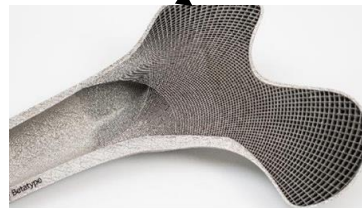
Trumpf



Csiri



GE



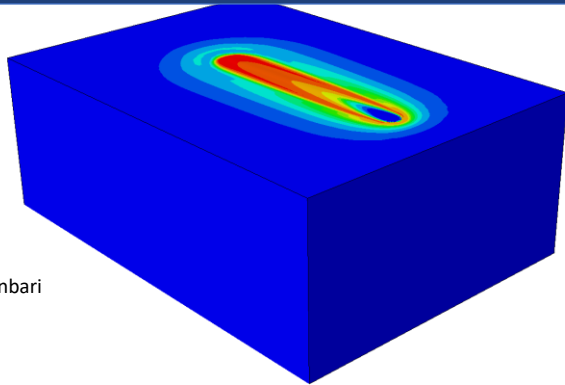
todaymedicaldevelopments.com

# Numerical efficiency and accuracy

## Small-scale thermomechanical simulations ( high fidelity )

S, Mises  
(Avg: 75%)

537
492
447
402
358
313
268
224
179
134
90
45
0



P Gh Ghanbari

- Spatial and temporal increments: 10 $\mu$ m and 10 $\mu$ s, respectively
- Adaptive re-meshing
- **Unrealistic** computational effort for component-scale

## Part-scale thermomechanical simulations ( low fidelity )

S, Mises  
(Avg: 75%)

1172
1000
917
833
750
667
583
500
417
333
250
167
83
0

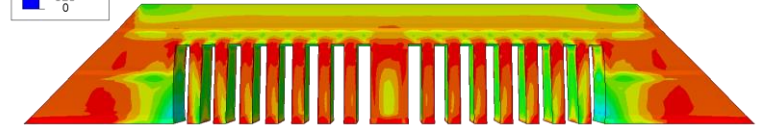


- Coarse time sequences and lumped layers
- Far-field temperature ✓
- Local temperature history ✗
- Residual stress modeling:  
Apply additional thermal strains to each activated layer

## Part-scale simulations: Inherent Strain Method

S, Mises  
(Avg: 75%)

1774
1500
1375
1250
1125
1000
875
750
625
500
375
250
125
0



- No heat transfer analysis
- Residual stress modeling:  
Apply incompatible strain field to each activated layer
- Extraction of inherent strain tensor:
  1. From experiments
  2. From simulations

# Validation?

# Support

Experimental validation of residual stresses and distortion:

- For small-scale simulations
- For part-scale simulations
- Methods?
- Equipment?

# Contact

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