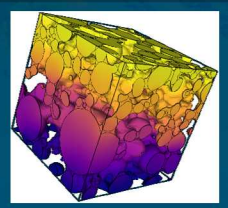
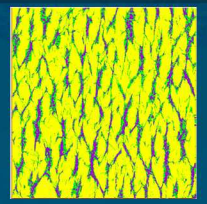
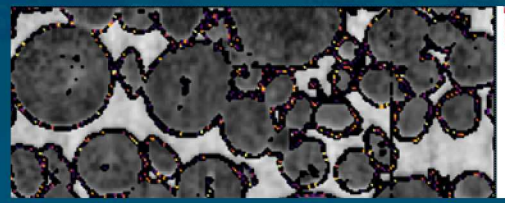
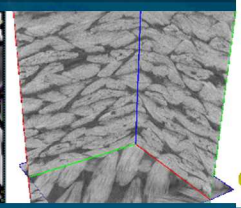
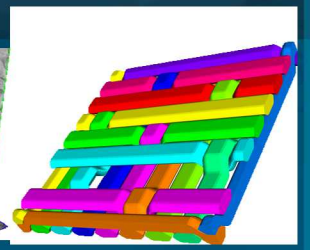
SAND2019-5563PE

Image-based geometry and simulation


PRESENTED BY

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Thermal/Fluid Component Sciences
Engineering Sciences Center

5/23/2019

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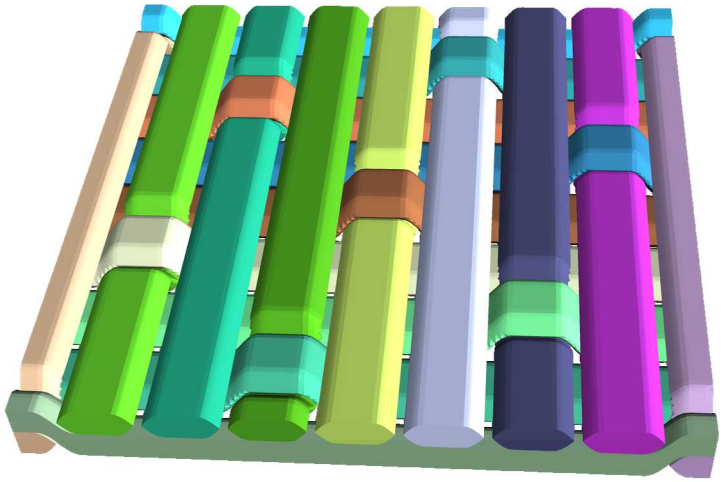
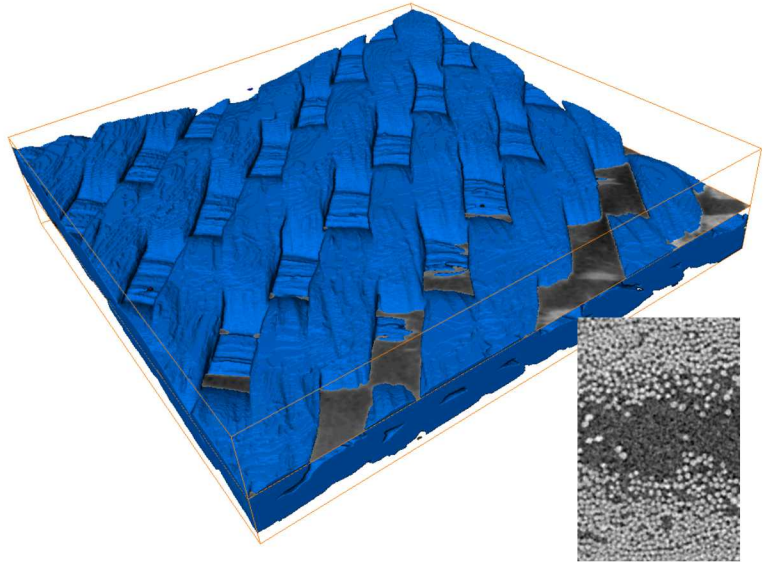
Image-based simulations



Simulated



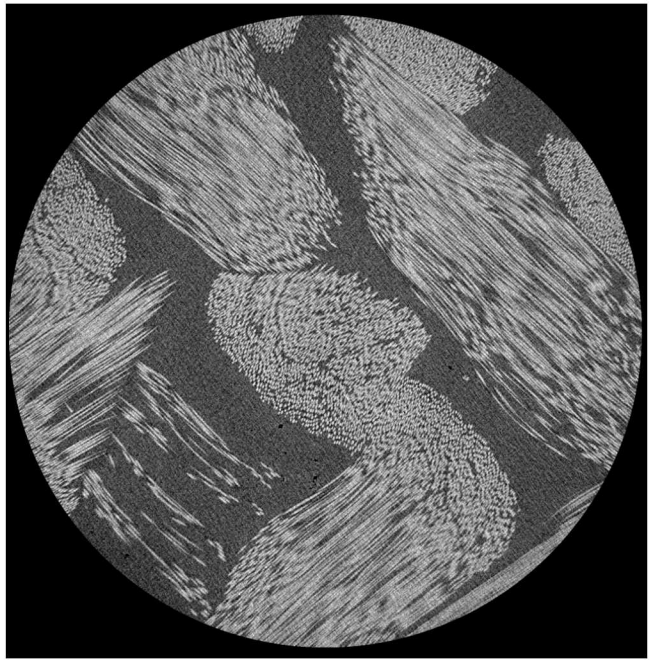
As-manufactured

Image-based simulations:

- Inform analytical geometric parameters for studies of composite effective properties
  - Measure geometric parameter ranges directly from samples
- Validation for models and simulated mesostructure

- Requires careful segmentation/processing of material scans
  - Creation of credible, reliable meshes with minimal manual intervention
  - **Fiber direction must be calculated**
  - Coupled with ML/DL methods

Image structure tensor



High res. XRCT (NASA-Ames)

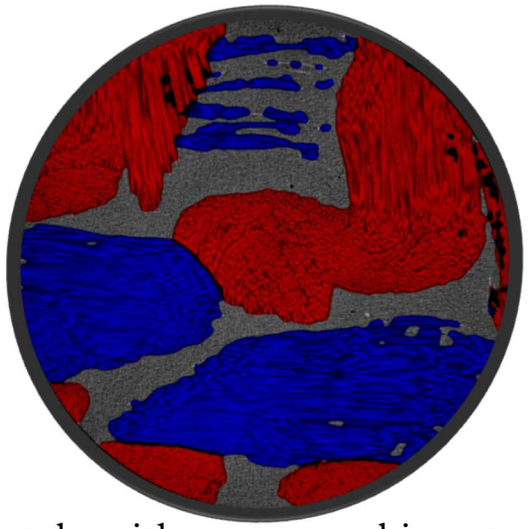
X Y Z

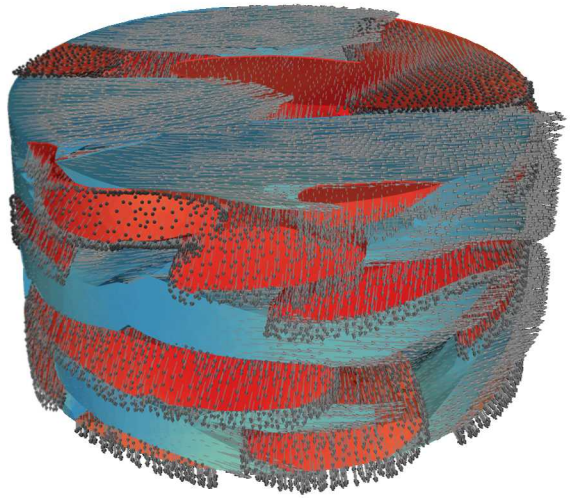
Image structure tensor:

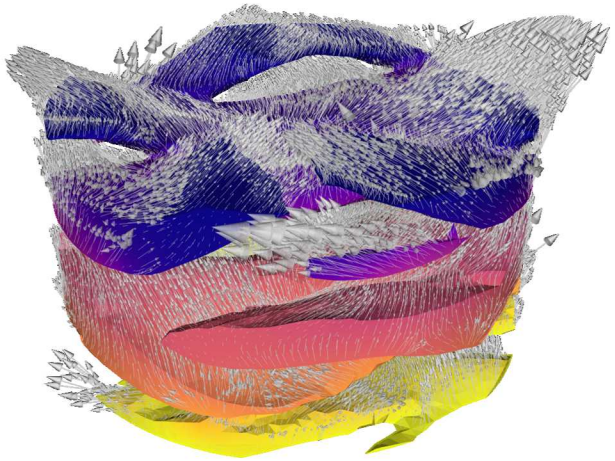
- "Gradient" of image intensity at each voxel
  - Gaussian blurred finite difference of intensity values
- Eigenvector associated with minimum eigenvalue denotes material direction
  - Lowest variation in image "texture"

- **Segment warp/weft directions separately**
- **Generate local material coordinate frame**

Anisotropic segmentation and meshing of TPS coupons

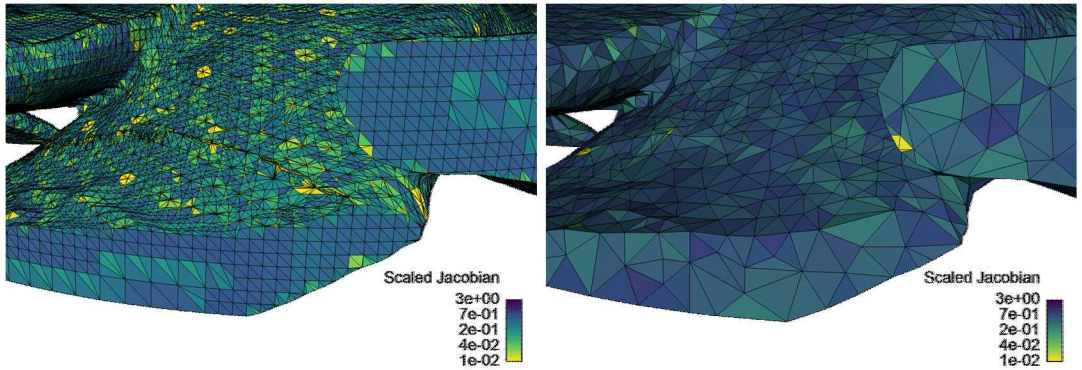






Heat flux

- Stack is segmented accurately with no manual input
- Simulation mesh generated using CDFEM and improved (coarsened) w.r.t. aspect ratio/edge length
- Local material orientation overlaid onto simulation mesh
  - Anisotropic effective properties used for yarn behavior
- Coupled simulations are easily performed using Sierra

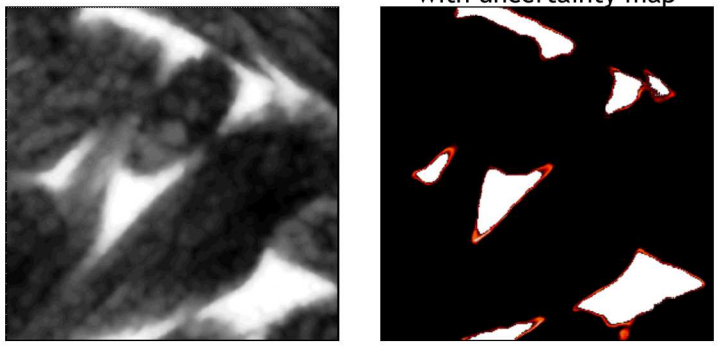


Thermal stress:

Next steps

Next up:

- Separate yarns in each direction
  - Analyze cross-sections/paths/fabric geometry etc.
- Comparison of composite properties to simulated geometry
- Apply methods to XRCT dataset of single layer/unit cell
- Train ML algorithm on segmented data with vector fields
  - Explore domain-shifted application of trained model
    - Lower res., materials, image sources
- Geometric sensitivity
  - Level set perturbation, adjoint methods etc.



TPS: Accurate segmentations on held-out sub-volumes, with per-voxel UQ