MODELING THE EFFECT OF POROSITY ON THE ELASTIC PROPERTIES OF SYNTHETIC GRAPHITE USING CT SCANS AND THE FINITE ELEMENT METHOD

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October 10th, 2013

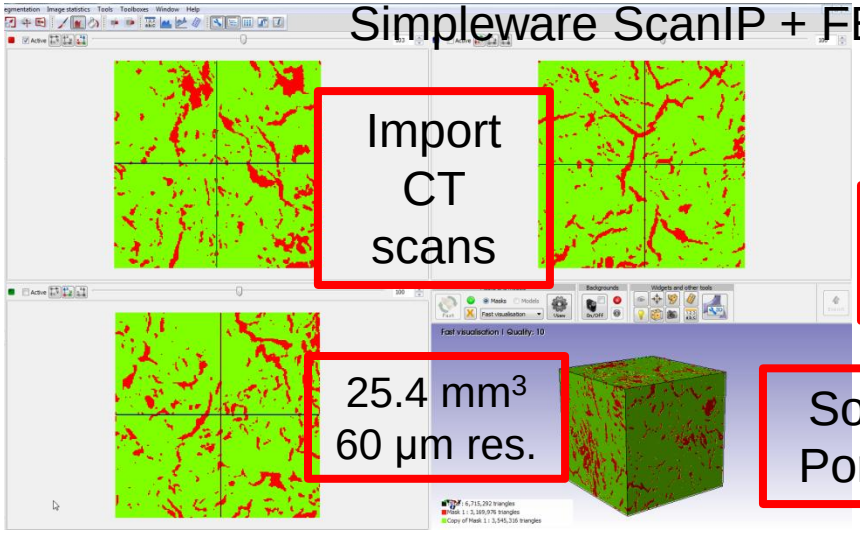
Agenda

- Introduction
- Workflow
  - Converting CT Scans to FEM using COMSOL and Simpleware
- Current Results
- Summary and Path Forward

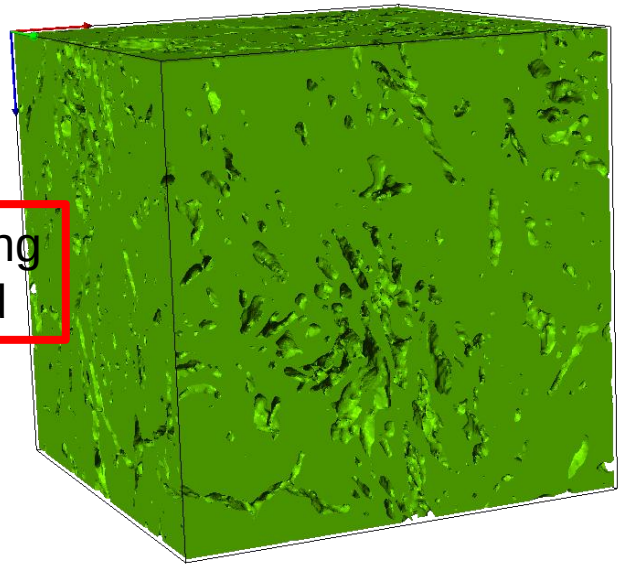
Introduction

- GrafTech has developed expertise in over 30 years of using finite element modeling (FEM) to solve complex thermo-mechanical problems involving synthetic carbon graphite materials.
- Traditionally, for a number of reasons, porous materials have been approximated with homogenous properties in FEM.
- Only recently has realistic porosity characterization, e.g. computed tomography (CT), been available.
- Only recently has software and hardware been commercially available capable of meshing, solving, and post-processing complex geometries such as those in porous materials for microstructural modeling.
- GrafTech is utilizing COMSOL and Simpleware to convert CT scans of porous materials into FE models for 3D mechanical and thermal modeling.

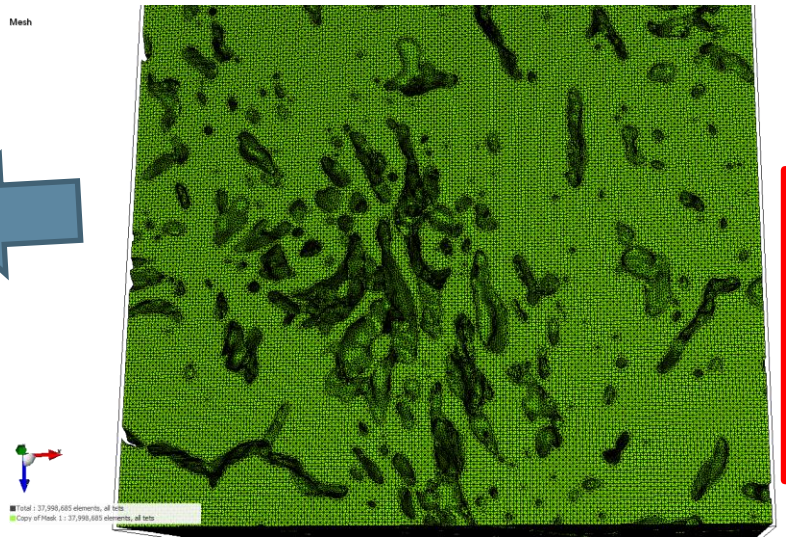
Workflow: Converting CT Scans to FEM

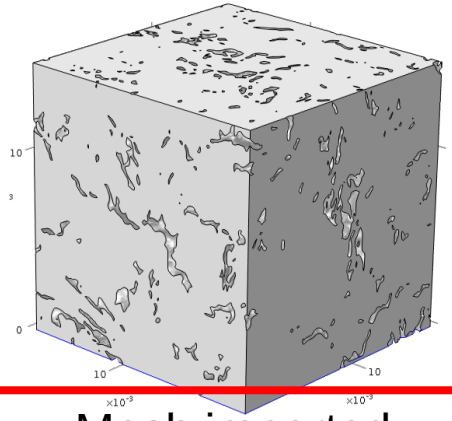


Rendering of solid



Meshing with Simpleware FE Grid or FE Free yields a high quality mesh

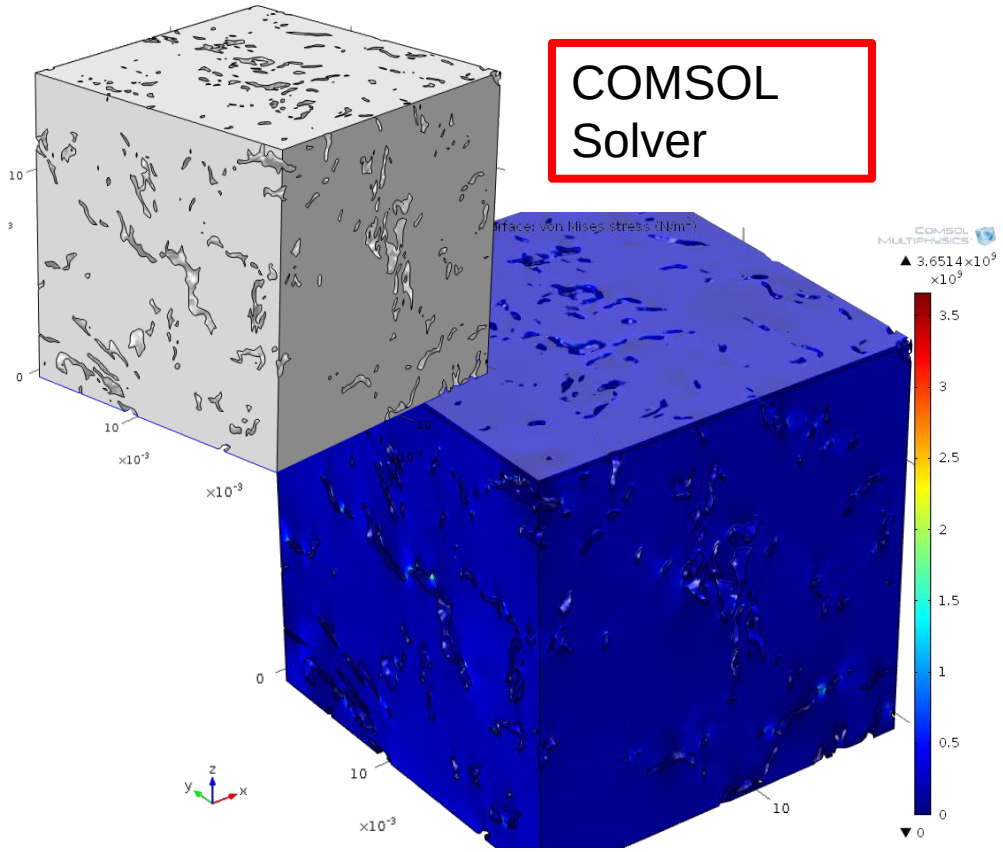


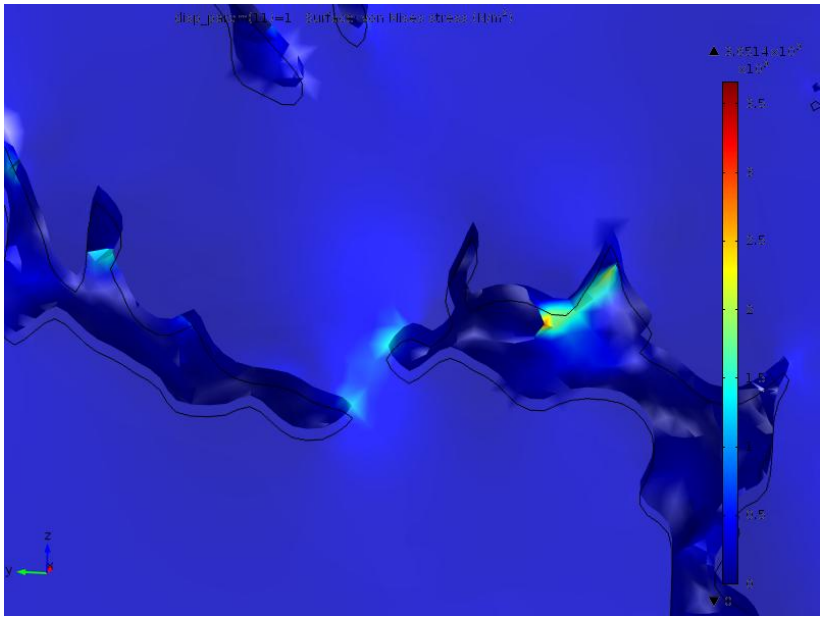


Mesh imported directly into COMSOL

Current Results: Effect of Porosity on Stress

COMSOL Solver





Model in COMSOL showing stress distribution. Reduction in elastic modulus and Poisson's ratio.
Study extensions

Stress concentration effect of porosity: between neighboring pores and at the edge of a single pore.
Implications for strength and fracture toughness.

Summary and Path Forward

Summary

- Successfully developed a workflow using Simpleware and COMSOL.
- Investigated the effect of porosity on elastic properties of several grades of synthetic graphite. Models were matched with measured properties.

Path Forward

- Just the beginning.
- Plan to model and test larger samples to compare with various mechanical tests, e.g. tension, compression, flexural, fracture.
- Continue to refine meshing and solving parameters.

The authors gratefully acknowledge the technical support that has been given by Simpleware, COMSOL, and AltaSim.