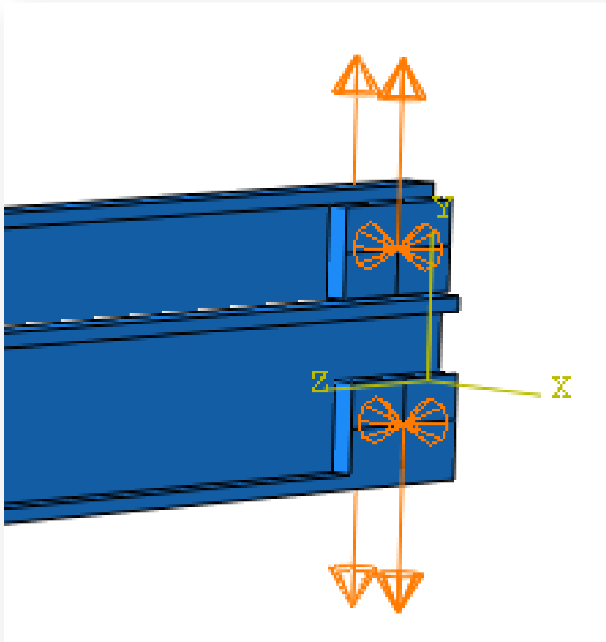
Master Thesis for Tetra Pak
Delamination of a paperboard using cohesive element

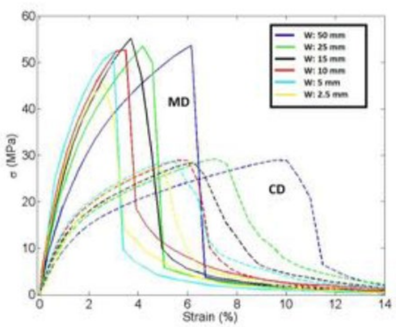


Development of a cohesive element

- Literature study
- Implementation of a cohesive law
- Out-of-plane simulations of
  - DCB specimens
  - CC specimens

- Contact
  - Johan.Tryding@tetrapak.com
  - Eric.Borgqvist@tetrapak.com

Master Thesis for Tetra Pak
Size effects in Paperboard



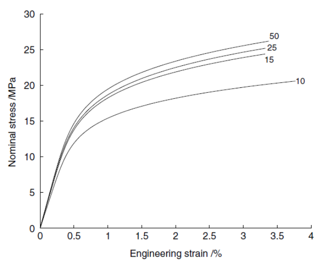


Fig. 11. Uniaxial material behaviour in CD as function of test piece width.

The stress-strain curves of paperboard is not invariant to scaling of geometry according to previous studies. A MSc thesis topic where this is investigated more deeply and techniques for modeling size effects is proposed.

- Performs test with different geometries of paperboard. Investigate if there is size-dependency
- Litterature study on techniques for modeling size effects. e.g. Strain-gradient plasticity.
- Establish constitutive model that takes into account size-effects.

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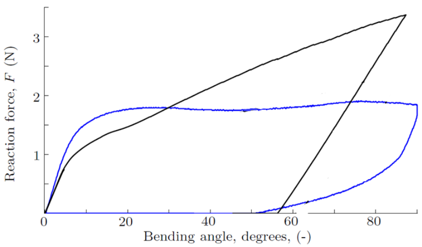
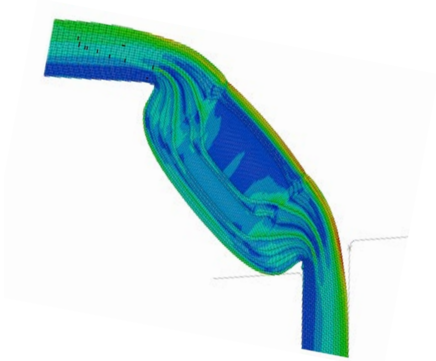
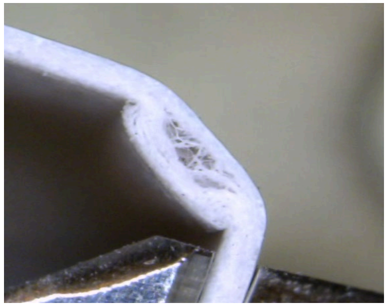
Master Thesis for Tetra Pak
Simulation of folding creased Paperboards







Improve simulations of folding creased paperboards

- Literature study
- Cohesive modelling technique of delamination
- Propose modeling strategy for combining 3d-plasticity model of paperboard with cohesive modeling of delamination.

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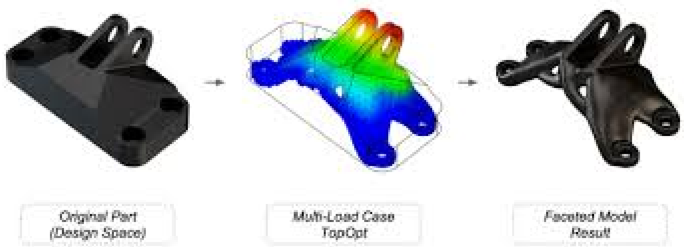
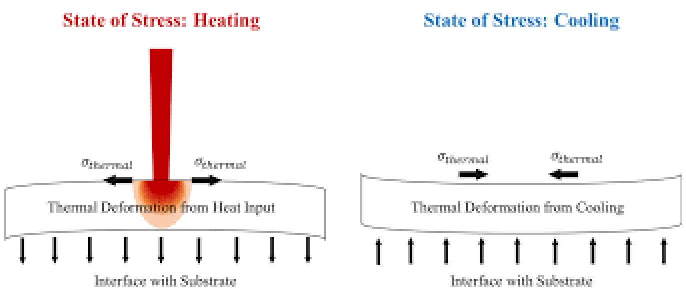
Mathias Wallin
Top. Optimization of thermal processes





- Topology Optimization is key to Additive Manufacturing
- Additive manufactoring suffers from residual stresses
- Task: Develop code for transient thermal topology optimization
- Required skills: Structural Optimization, Finite Element Method, Non-linear finite Element Method

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Contact
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Master's Thesis Proposal

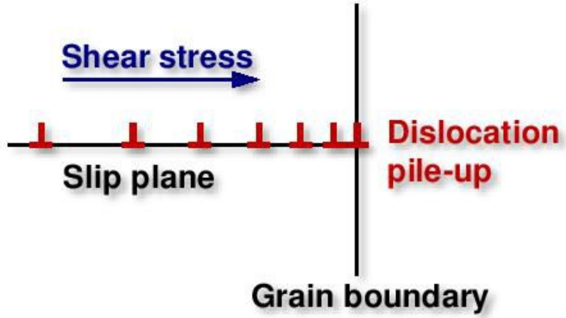
Reaction-Diffusion Modeling of Dislocations

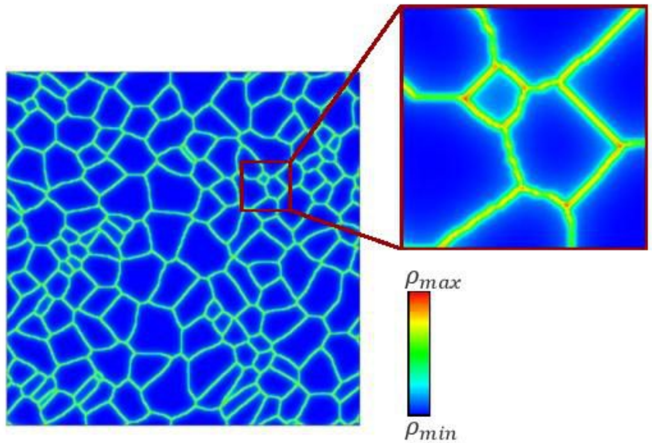
Background

In metals, *dislocations* (imperfections in the crystal lattice) are central to plastic deformation of the material. The distribution of the dislocations in the material microstructure and the formation of dislocation patterns have a major impact on the material properties. One effect is the classical Hall-Petch relation, whereby smaller crystals give a harder material. This is related to dislocation pile-ups at the grain boundaries.

Project

This project will use a so-called *reaction-diffusion* approach to model the stability of the dislocation distribution in metal microstructures and the formation of dislocation patterns. The modeling will be performed using finite difference and/or finite element methods. The project is directly linked to ongoing research





References

- H. Hallberg and M. Ristinmaa (2013), *Microstructure evolution influenced by dislocation density gradients modeled in a reaction-diffusion system*, Computational Materials Science, 67:373-383

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Master's Thesis Proposal

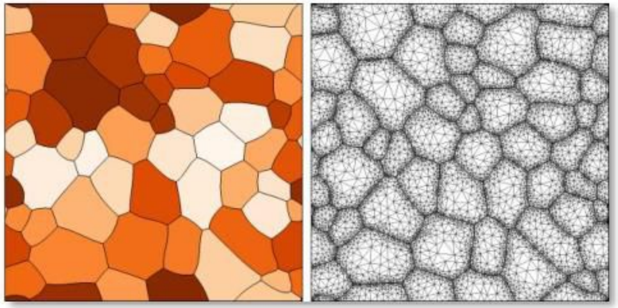
Physics-Based Mesh Adaption

Background

Microstructure changes in metals is mainly due to the movement of interfaces, such as grain boundaries. To trace the interface evolution a very fine mesh is required. However, using a very fine mesh everywhere will be too computationally expensive. The solution is an *adaptive mesh* which is continuously adapted to the moving interfaces.

Project

This project will consider microstructure physics such as interface curvature and gradients in the fields which move the interfaces to control the mesh size in critical regions. The interfaces will be modeled by so-called *level sets*. A Fortran-based finite element implementation of level sets exists and the project will focus on improving the meshing algorithm. The project is directly linked to ongoing research



References

- H. Hallberg (2014), *Influence of anisotropic grain boundary properties on the evolution of grain boundary character distribution during grain growth - A 2D level set study*, Modelling and Simulation in Materials Science and Engineering, 22(8):085005
- H. Hallberg (2013), *A modified level set approach to 2D modeling of dynamic recrystallization*, Modelling and Simulation in Materials Science and Engineering, 21(8):085012

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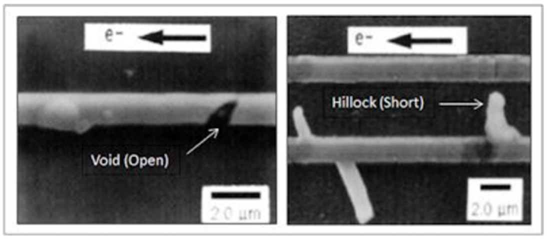
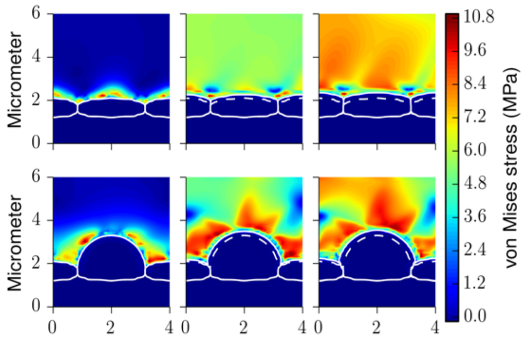
Johan Hektor
Modelling of electromigration





- Mass transport driven by an electric field
- Can lead to voids and whiskers/hillocks in e.g. solder joints.
- Develop a numerical model
  - time-dependent finite element model
  - phase field approach
  - implement the model in FEniCS
- Literature: Park et al. 2013
  Hektor et al. 2016

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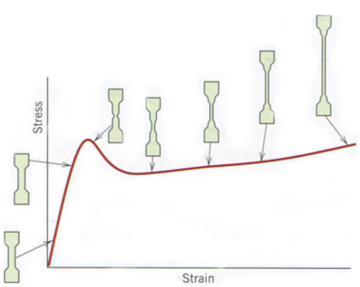
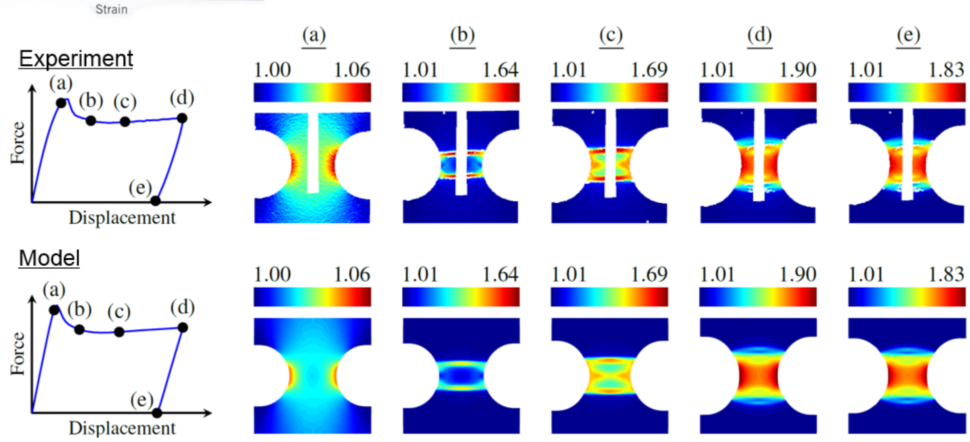
Jonas Engqvist
Numerical efficient polymer model



- Literature study
- Achieve a numerically efficient implementation of a polymer model
- One aim is to use the implemented model in optimisation



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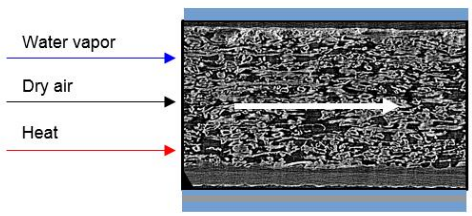
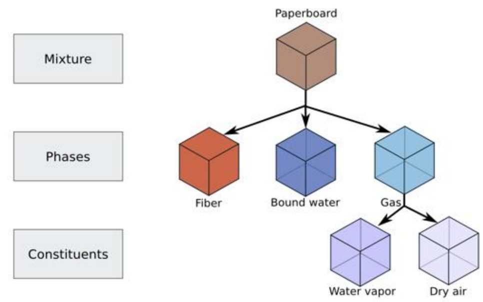
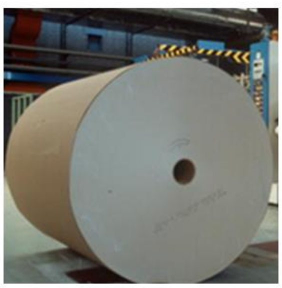
Marcus Alexandersson
Implementation of multi-physics model

What is this?

- Multi-physics transport model for prediction of moisture and temperature profiles in paperboard.



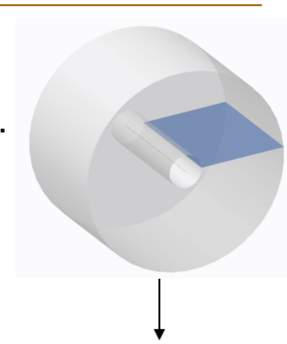




Marcus Alexandersson
Implementation of multi-physics model

What is this?

- Model implementation in a commercial software.



$$[n_s\rho_s c_s^v + n_l\rho_l c_l^v + n_g\rho_g c_g^v]\frac{\partial\theta}{\partial t}$$
$$\frac{n_s\rho_s}{\rho_l}[\rho_l W\frac{\partial u_l}{\partial W} - \rho_g u_g + \rho_l u_l]\frac{\partial W}{\partial t}$$
$$+ n_g u_{g_v}\frac{\partial\rho_{g_v}}{\partial t} + n_g u_{g_a}\frac{\partial\rho_{g_a}}{\partial t}$$
$$+ \nabla\cdot[\hat{\boldsymbol{q}} + n_g\rho_g h_g \boldsymbol{v}_{g,s}] = 0$$

$$\frac{\partial W}{\partial t} + \frac{\dot{m}_v}{n_s\rho_s} = 0$$

$$n_g\frac{\partial\rho_{g_v}}{\partial t} - n_s\rho_s[\frac{\rho_{g_v}}{\rho_l} - 1]\frac{\partial W}{\partial t} + \nabla\cdot[n_g\rho_{g_v}(\boldsymbol{w}_{g_v} + \boldsymbol{v}_{g,v})] = 0$$

$$n_g\frac{\partial\rho_{g_a}}{\partial t} - \rho_{g_a}\frac{n_s\rho_s}{\rho_l}\frac{\partial W}{\partial t} + \nabla\cdot[n_g\rho_{g_a}(\boldsymbol{w}_{g_a} + \boldsymbol{v}_{g,s})] = 0$$

$$p_{g_v} = \rho_{g_v}\frac{R\theta}{M_{g_v}}$$

$$p_{g_a} = \rho_{g_a}\frac{R\theta}{M_{g_a}}$$

$$p_g - p_l = -\rho_l W\frac{\partial A_l}{\partial W}$$

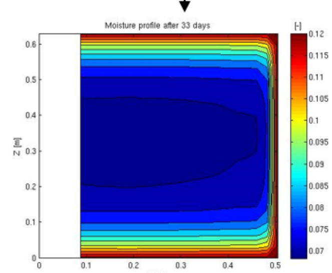
$$\boldsymbol{w}_{g_v} = -\boldsymbol{D}_{g_v}\cdot n_g\rho_{g_v}\nabla(\mu_{g_v} - \mu_{g_a})$$

$$\boldsymbol{w}_{g_a} = -\boldsymbol{D}_{g_a}\cdot n_g\rho_{g_a}\nabla(\mu_{g_a} - \mu_{g_v})$$

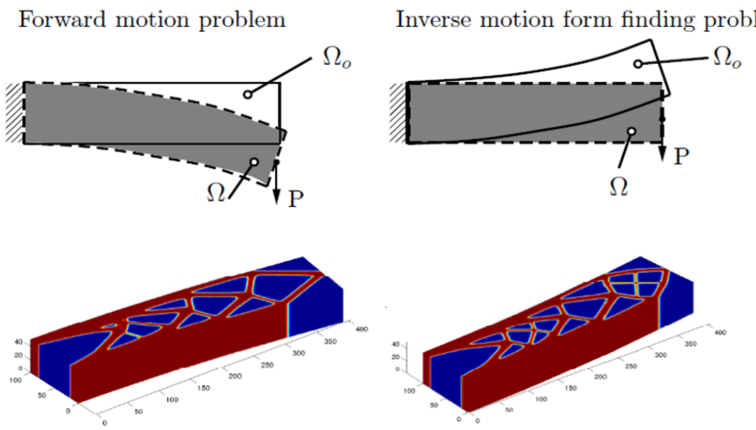
$$\boldsymbol{v}_{g,s} = -\boldsymbol{K}_{g,s}^p\cdot n_g\nabla(p_g)$$

$$\hat{\boldsymbol{q}} = -\boldsymbol{K}\cdot\nabla(\theta) - [-n_g\rho_{g_v}\boldsymbol{w}_{g_v}(\mu_{g_v} - \mu_{g_a})]$$

$$\dot{m}_v = k[G_l - G_{g_v}]$$



Mathias Wallin
Inverse Motion Topology Optimization



- Extend the existing framework
- Literature:
  Wallin and Ristinmaa (2015)
- Prerequisites:
  Structural Optimization
  Non-linear Finite Element

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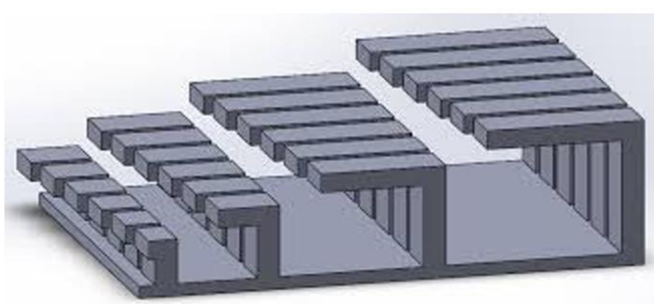
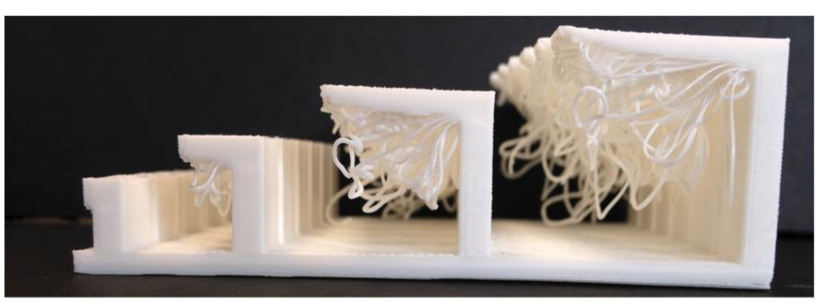
Mathias Wallin
AM & Topology Optimization

- Review literature
- Implement at methods capable of handling manufacturing constraints
- Prerequisites:
  Structural Optimization
  Non-linear Finite Element





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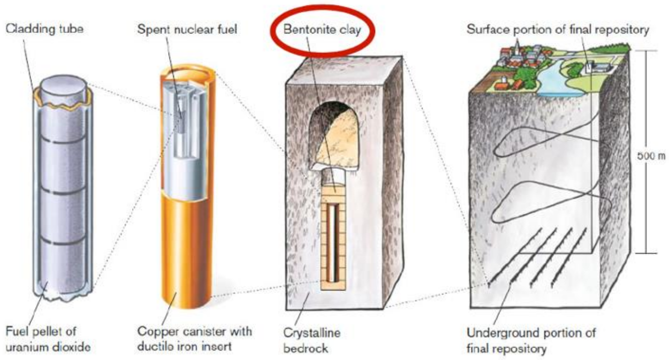
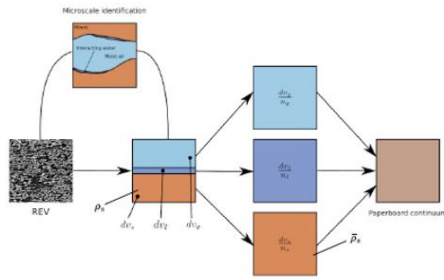
Matti Ristinmaa
Mixture theory for bentonite clay



Bentonite is dry when installed
- Swells due to water and changes the stresses
- Heat generation changes the water transport



- Build knowledge around mixture theory
- Define a suitable mixture theory for bentonite clay
- Implementation, numerical simulations

CLAY TECHNOLOGY AB

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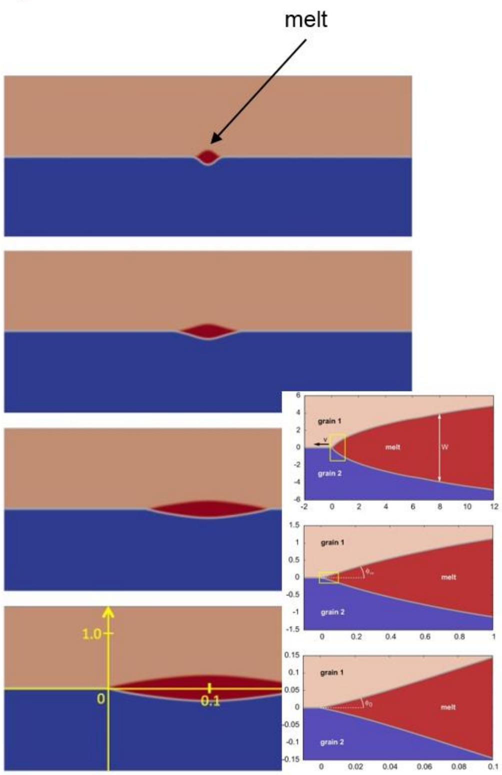
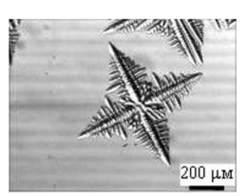
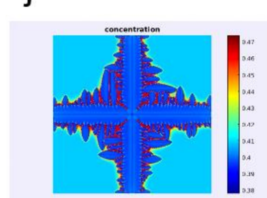
Ralf Denzer
Melting of metals: Numerical modelling



- Develop a numerical model using
  - transient finite element model
  - phase field approach
- Work program
  - melting of a pure metal phase
  - melting along grain boundaries
- Literature: Bhogireddy et al. 2015
- Last Master Project: Solidification





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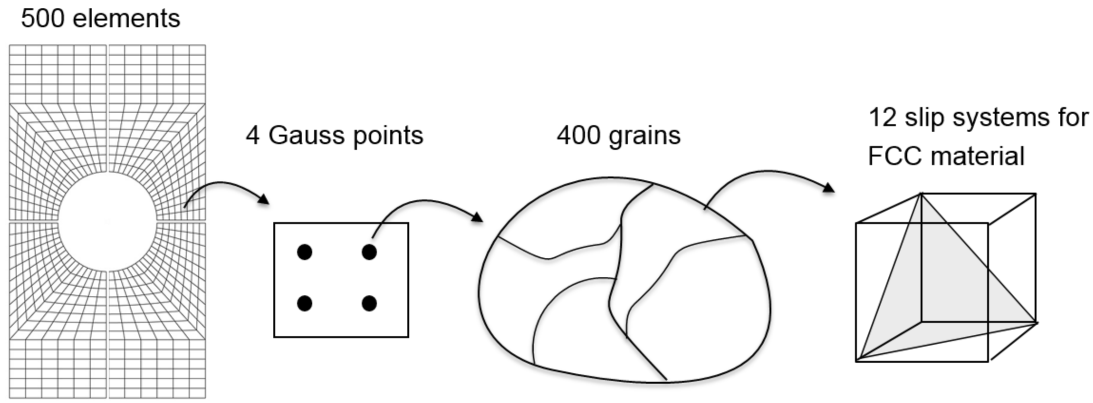
Sally Issa
Crystal plasticity



During forming processes of polycrystalline material, large plastic deformations occur and reorient the grains, resulting in a textured material. Texture can have an important influence on material properties and it is therefore important to accurately predict the texture evolution of metals during deformation.

- **Robust numerical method**
- **Constitutive modelling**
- **Nonlinear FEM**

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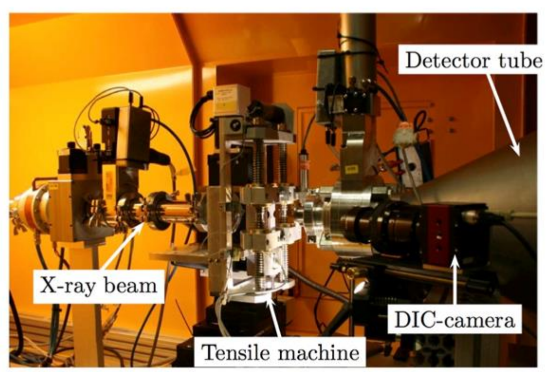
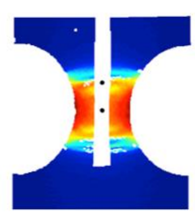
Steve Hall
Research projects in Polymer Mechanics

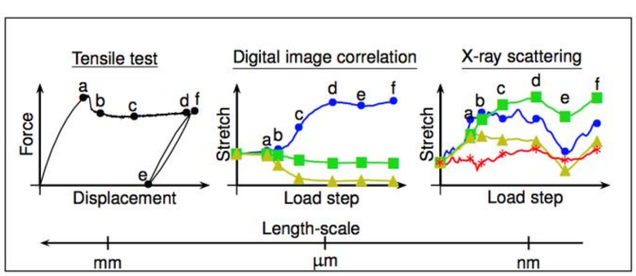
Multi-scale mechanics of polymer materials

Investigation of the mechanics of polymers (amorphous, semicrystalline and nano-structured) using:

- **X-ray scattering** – molecular scale deformation mechanisms
- **Digital image correlation** – local strain fields







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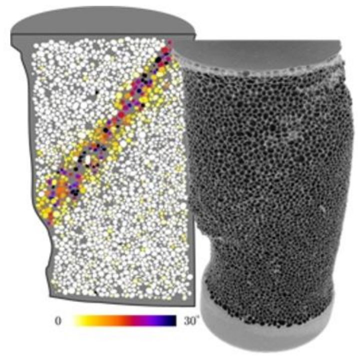
Steve Hall
Research projects in Granular Mechanics

4D Granular mechanics

Investigation of mechanisms in the deformation of granular materials using:

- 4D imaging by **X-ray tomography** using the state-of-the-art x-ray tomograph @ Solid Mechanics
- 4D **image analysis**
- Combined with **ultrasonic velocity** measurements
- Investigate relationship between elastic property evolution and granular structure



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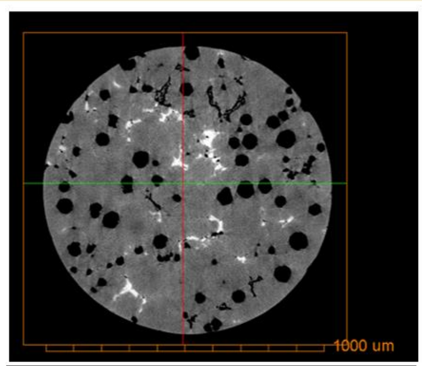
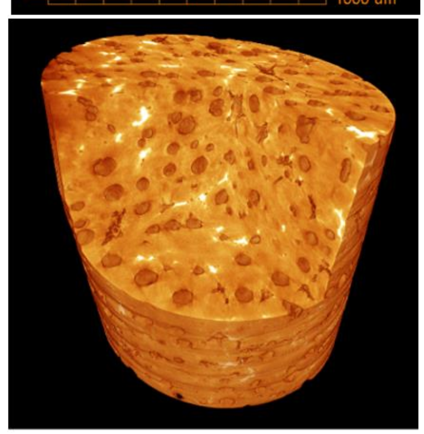
Steve Hall
Research projects in Granular Mechanics

4D mechanics of Cast graphite Iron (CGI)

Investigation of multi-scale deformation mechanisms in CGI using:

- 4D imaging by **X-ray tomography** using the state-of-the-art x-ray tomograph @ Solid Mechanics
- 4D **image analysis**
- Combined with **Diffraction Contrast Tomography** to image crystalline structure and deformation mechanisms (completely new technique that will become available soon at the lab)





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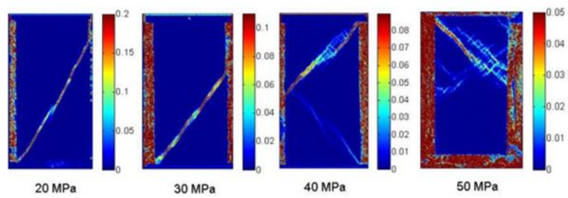
Stefanos Athanasopoulos
DIC-based Experiments on Rocks

- **Strain localisation in granular rocks** through Digital Image Correlation (DIC)
- Combination with under development **Ultrasonic Transducer Array** (current Masters project)
- Part of the development of a **Prototype high pressure plane-strain cell** for Neutron Diffraction-based experiments on rocks



Lanata (2015)

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