



Group assignments



The plan



- In groups of 5
- Use the software Elle to investigate one question
- Run simulations to vary parameters
- Answer the question
- Report in <15 min presentation on day 9



6 assignments



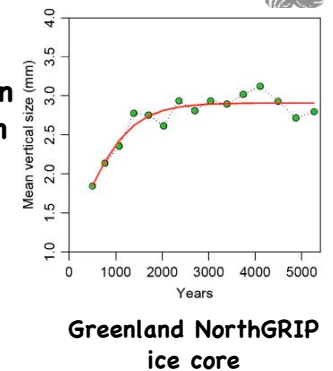
1. Grain growth and grain size reduction
2. Grain growth during deformation
3. Tracking swept area during grain growth
4. Mechanical properties of 50-50% aggregate with soft inclusions
5. Mechanical properties of 50-50% aggregate with hard inclusions
6. Mechanical properties of 2-phase system as function of composition



Grain growth and grain size reduction



- Reduction of total surface energy is achieved by a reduction of grain boundary area (length in 2D), leading to
 - an increase in grain size
 - The formation of a foam texture
- Other processes, such as subgrain formation, lead to a reduction of grain size
- **Is there a stable grain size?**
- **What is the resulting microstructure?**
- **What does the grain size evolution look like?**





Implementation



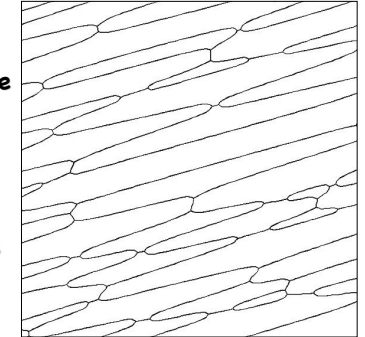
- **Elle_gg**: Module that simulates static grain growth driven by a reduction in surface energy
- **Elle_split**: Module that randomly splits grains into two parts
- Parameters to play with:
 - Product of grain boundary energy and grain boundary mobility
 - The chance that a grain is split during one time step
 - Dimensions of the system and size of time step
 - Initial microstructure



Grain growth during deformation



- Reduction of total surface energy is achieved by a reduction of grain boundary area (length in 2D), leading to
 - an increase in grain size
 - The formation of a foam texture
- Deformation modifies the microstructure
- **How does deformation affect**
 - The resulting microstructure?
 - The grain growth law?



Implementation



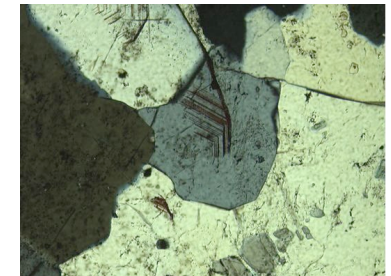
- **Elle_gg**: Module that simulates static grain growth driven by a reduction in surface energy
- **Manuel**: Module that applies an increment of homogeneous simple shear to all nodes
- Parameters to play with:
 - Product of grain boundary energy and grain boundary mobility
 - The shear rate
 - Dimensions of the system and size of time step
 - Initial microstructure



Tracking swept area during grain growth



- During grain growth, grain boundaries sweep through the material
- Material being swept is in contact with the sweeping grain boundary, and may change chemically
- **What is the fraction of swept material as a function of**
 - Amount of grain growth?
 - Initial microstructure?

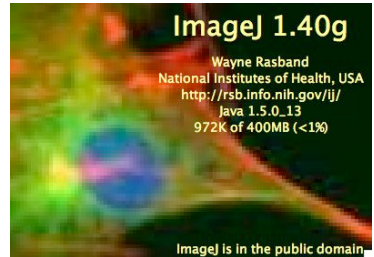




Implementation



- **Elle_gg**: Module that simulates static grain growth driven by a reduction in surface energy
- **ImageJ or other image processing program**: measure swept area
- Parameters to play with:
 - Initial microstructures
 - Others can be added at own risk



<http://rsb.info.nih.gov/ij/>



Implementation



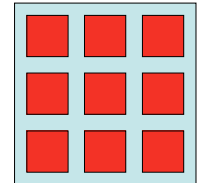
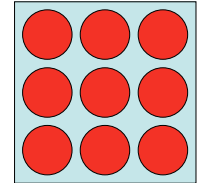
- **Basil**: FEM Module for incompressible isotropic viscous flow
- **Sybil**: Analyse stress and strain rate
- Parameters to vary:
 - Initial phase distribution
 - (Stress exponent)
- **One group**: soft inclusions in percolating hard matrix
- **Other group**: hard inclusions in percolating soft matrix



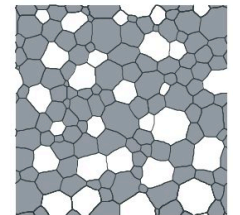
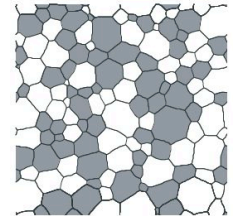
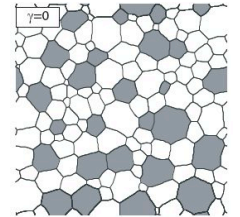
Mechanical properties of 50-50% aggregate



- The bulk viscosity of a $\pm 50-50\%$ composite depends on
 - The viscosity of the two phases
 - The distribution of the phase regions
- How does the bulk viscosity depend on
 - Phase distribution?
 - Amount of strain (up to $\gamma=1$)?
- What is the strain (rate) distribution?



Mechanical properties of 2-phase system as function of composition



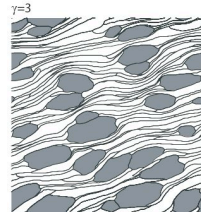
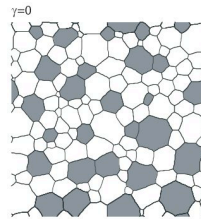
- The bulk viscosity of a 2-phase composite depends on
 - The relative fractions of the phases
 - Their distribution
- For a given distribution or microstructure, what is the bulk viscosity as a function of
 - composition?
 - Viscosity contrast?
- What is the effect of strain?



Implementation



- **Basil:** FEM Module for incompressible isotropic viscous flow
- **Sybil:** Analyse stress and strain rate
- **Parameters to vary:**
 - Proportion of the two phases
 - Microstructure
 - (Stress exponent)
 - Finite strain



6 Groups



Lateef	AKANJI	1	Laura	COTTON	4
Maria	HÖRHOLD	1	ZEYNEP	KECELI	4
LI	LI	1	Christian	PETRICH	4
Julia	SCHNEIDER	1	Vladimir	Kusbach	4
Carlos	TRENADO	1	Asma	YAHYUCHE	4
Pierre	BACHAUD	2	Oliver	GAEDE	5
Philippe	IAFISCO	2	Ingólfur	KOLBEINSSON	5
Jeff	MARSH	2	Gustavo	PLAZA	5
CLAUDIA	SECRIERU	2	Viktoriya	YARUSHINA	5
Robin	WALTON	2	Pavel	GAVRYUSHKIN	6
Mandy	BRAATZ	3	Yuan-Tsan	TSENG	6
Juan Ernesto	JURI	3	Ansgar	SCHEPERS	6
Maciej	MATYKA	3	Elsa	VITORGE	6
Ewa	STODOLAK	3	Christian	KLIMCZAK	6
Karen	WONSYLD	3			



Good luck!

