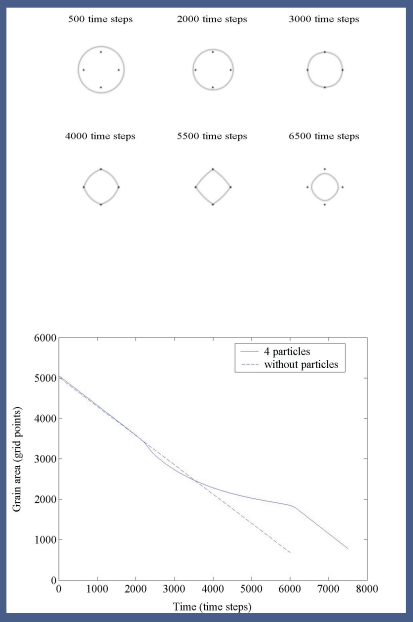
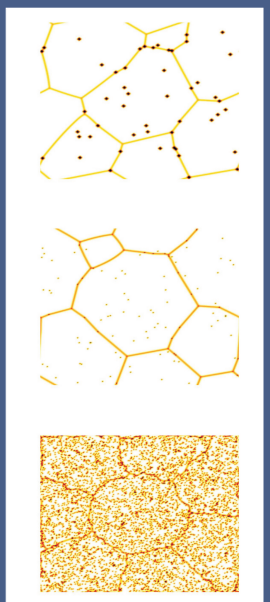
Abstract: The pinning effect of second-phase particles on grain boundaries has been simulated using the Phase Field method. An existing Phase Field model for grain growth in single-phase materials has been modified to take the presence of small particles, like precipitates and inclusions, into account. The influence of the volume fraction and the size of the second-phase particles has been examined and the results have been compared with analytical and statistical models and Monte Carlo simulations. Difficulties encountered in simulating grain growth with the Phase Field method mainly originate from the diffuse interphases and computational limitations.

Simulation Results

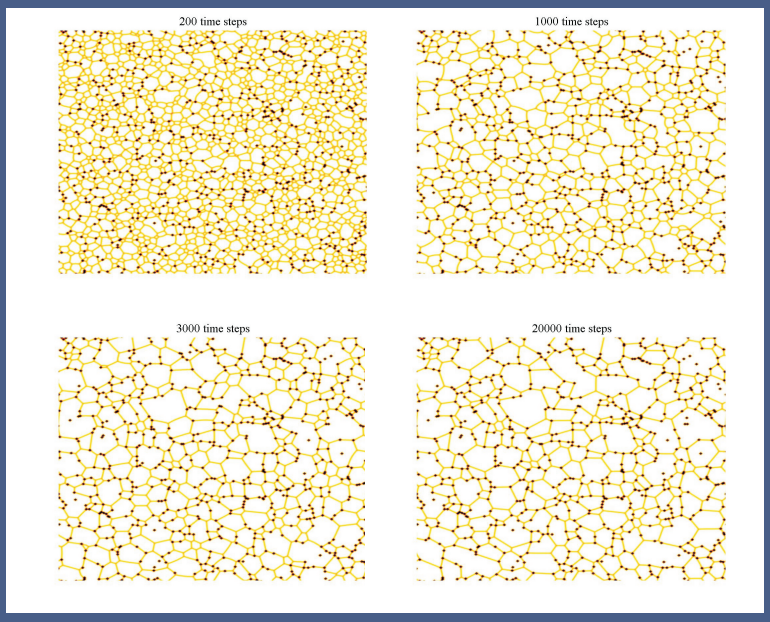
Circular grain



Seven-sided grain

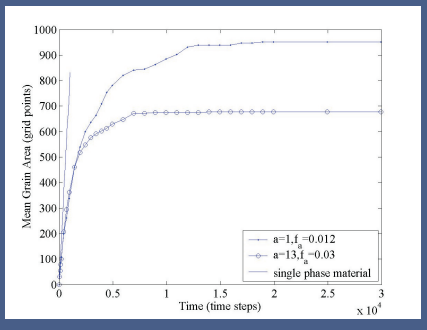


Polycrystalline microstructure



Comparison with experiments and Monte Carlo simulations

Evolution mean grain size



$A \propto t^n$

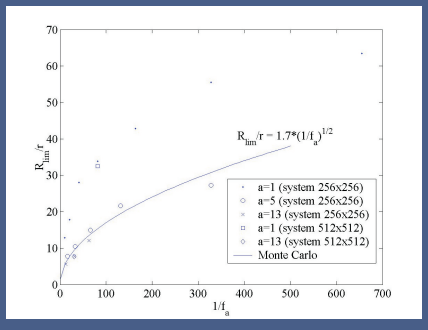
Single phase material : n = 1

With second-phase particles :

MC : n = 0.8 (initially)

PF : n = 0.88 (initially)

Limiting mean grain size



Analytical models : $\frac{R_{lim}}{r} = b\,\frac{1}{f_v^m}$

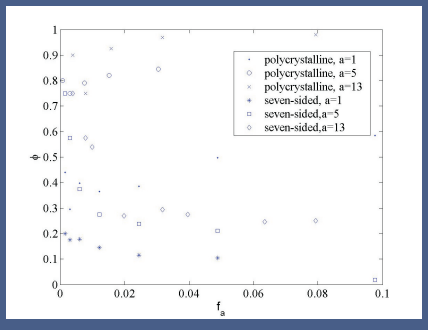
Experimental measurements:

low volume fraction : m = 1

high volume fraction : m = ½

MC-simulations (2D) : m = ½

Fraction on grain boundaries



Depends on

-pinning force of a particle

-ratio between initial grain size and interparticle distance

Most MC-simulations : $0.9 < \phi < 1$

PF-simulations : $\phi_{random} < \phi < 1$

Experiments : $\phi_{random} < \phi < 1$

a : particle area, r : particle radius, R : grain radius, l : grain boundary thickness, t : time, f_v : volume fraction particles, f_a : area fraction particles