Dynamics of Si surface morphology

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Motivation
Control of nanostucture self-assembly
- Understanding step motion during homoepitaxy
- Position control of nanostuctures using steps as templates

Approach
Many complicated processes involved a vast number of atoms
- A few parameters in diffusion equation

Experimental
Low-energy electron microscopy (LEEM)
- LEEM can routinely image surface structures in a spatial resolution of ~1 nm in a temporal resolution of ~1 s
- LEEM is suitable for studying surface dynamical processes

Diffusion equation
\[
\frac{\partial C}{\partial t} = D \nabla^2 C
\]
- Solved in the actual geometry using the Finite element method
- Solution for diffusion equation

Summary
- Understanding the surface mass transport
- Control of the step morphology
- Nanotube growth
- Nanowires growth

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Step control
- Step control
- Continuum of line
- Self-assembly

Surface mass transport
- Surface mass diffusion constant strongly depends on the structure.

Step wandering
- Step wandering induced by homoeptaxy on Si(m)
- Faster decay of islands with metastable structures
- Difference in the surface energy

Domain coarsening
- Von Neumann’s law well explains the coarsening of \( \zeta \gamma \) domains.

Void growth
- \( \delta k \delta \zeta \delta \gamma \) The peripheral reaction of the Si monomer with the oxide controls the void growth.
- Thermal decomposition of SiC on Si(111)
- Void growth during growth.

Von Neumann’s law
- \( \delta k \delta \zeta \delta \gamma \) The rate of change of area of the cell with \( \delta k \) sides

Curvature rate
- \( \frac{\delta A}{\delta t} = K \delta A / \delta l \)
- The enclosed area decreases at a constant rate.
- \( \frac{\delta A}{\delta t} = -2 \omega \mu \rho \delta A / \delta l \)
- Speed of void growth

Time dependence of domain sizes
- \( \delta k \delta \zeta \delta \gamma \) Computation of the rate of change of area of the cell with \( \delta k \) sides
- \( \delta k \delta \zeta \delta \gamma \) The rate of change of area of the cell with \( \delta k \) sides

Control of nanostucture self-assembly