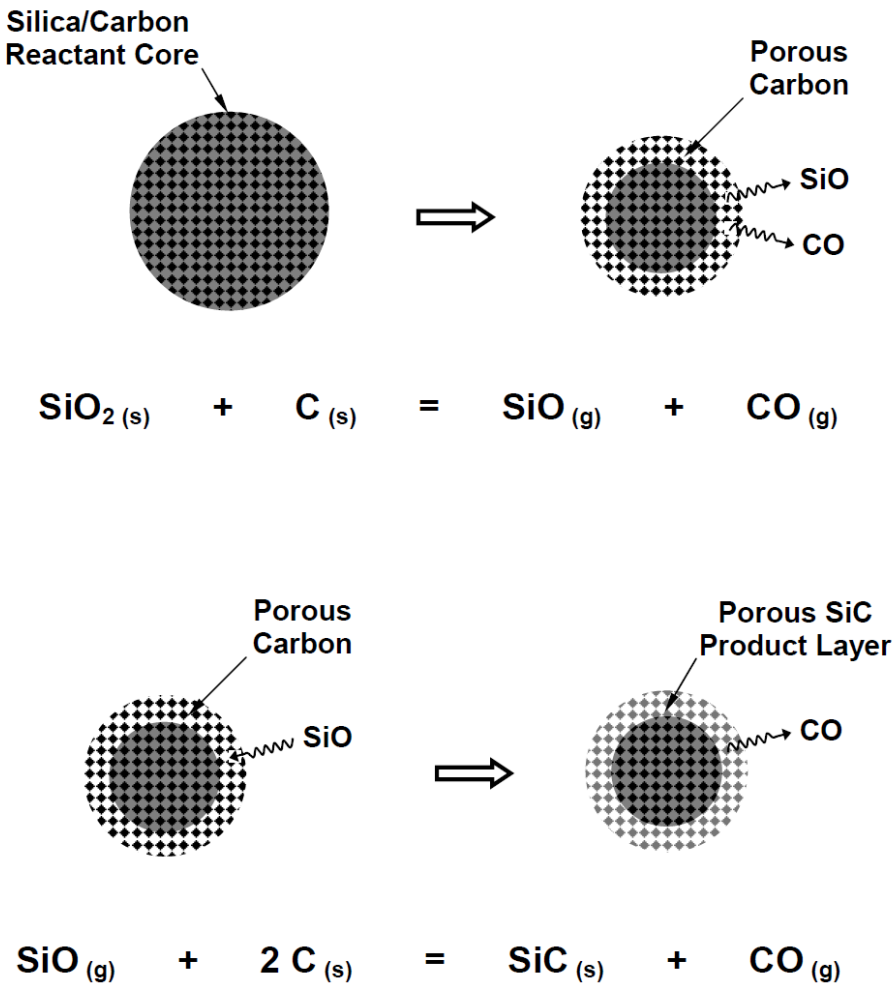
EMA5001 Lecture 24
Transformation Kinetics for SiC Formation

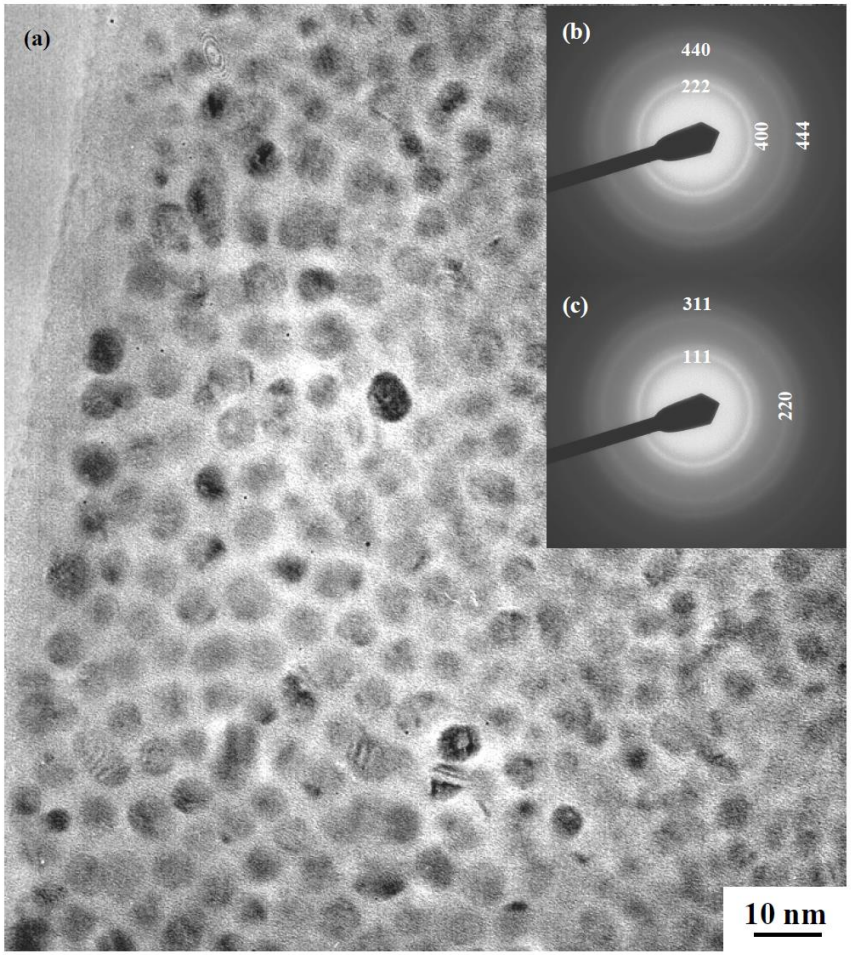
FLORIDA INTERNATIONAL UNIVERSITY

Kinetics for the Formation of Nano SiC via Carbothermal Reduction Reaction

- **Overall Reaction:** $SiO_2 + 3C = SiC + 2CO$



Nano-scale SiO_2-C Mixture



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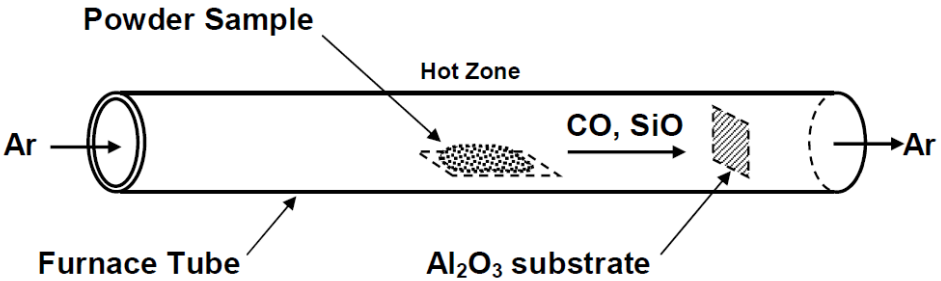
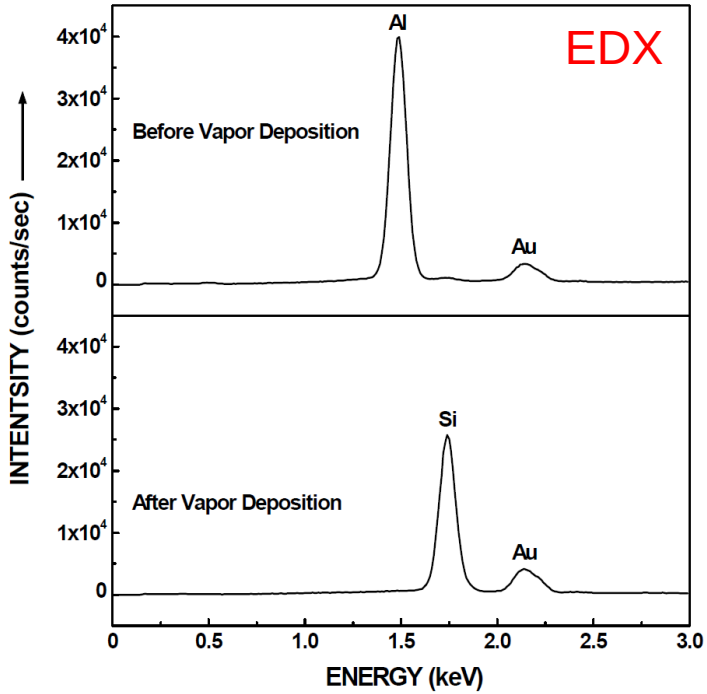
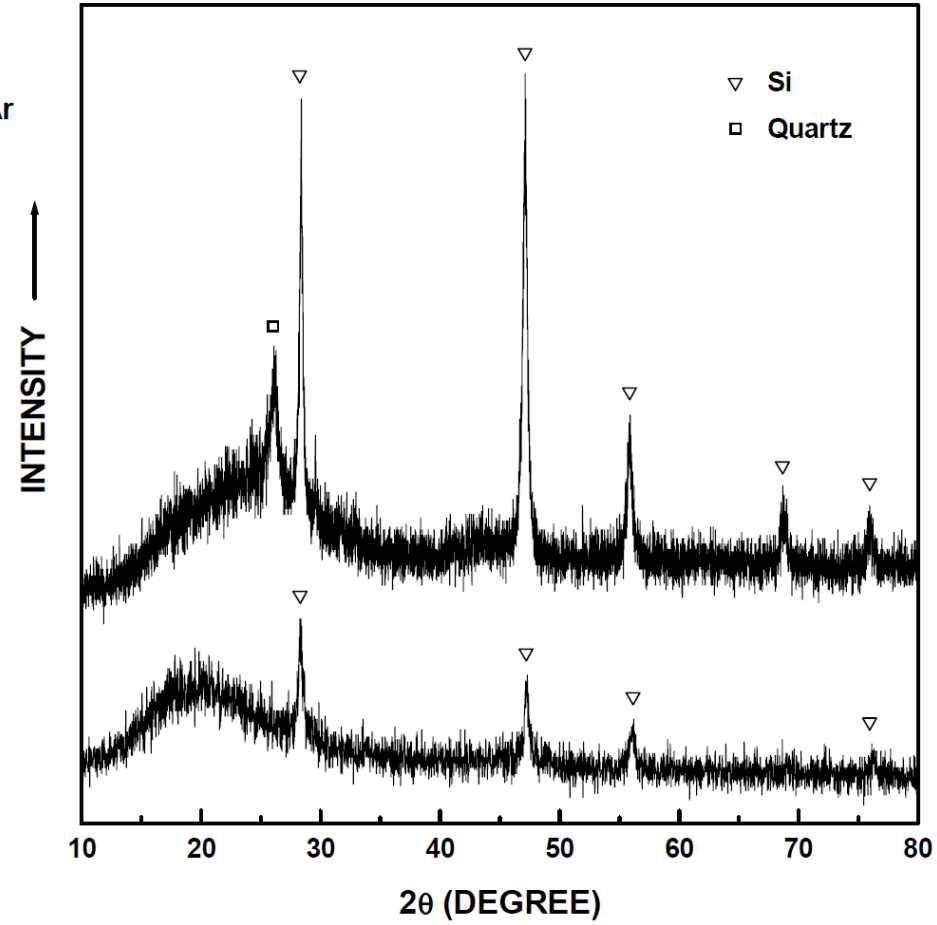
Confirmation of SiO & the Two-Step Reaction





XRD of Vapor Deposits



$SiO = Si + SiO_2$

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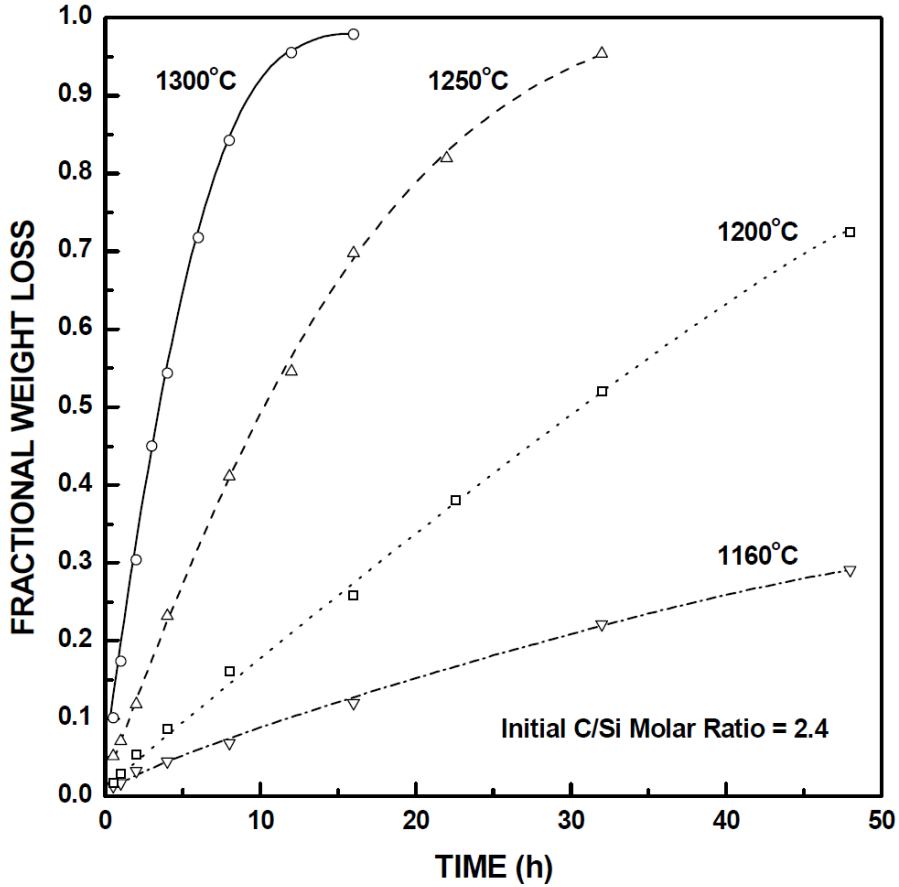
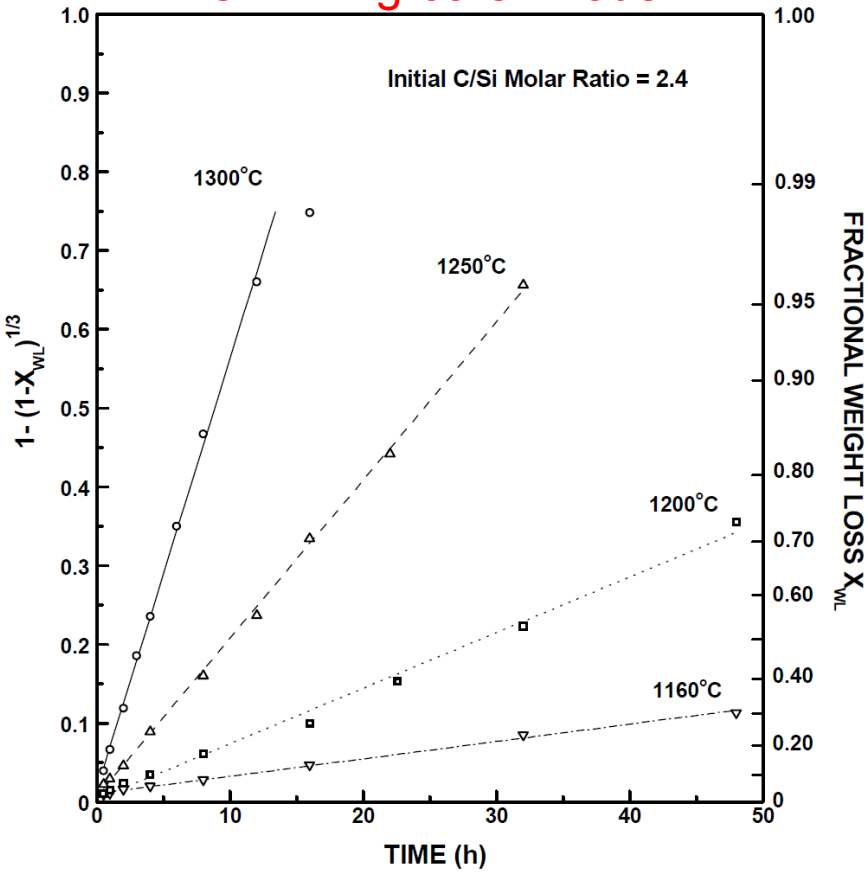
Reaction Kinetics from Weight Change

- Best fit to Interface-controlled "Grow in"/"Shrinking Core" model

Weight Loss Data



Fitting to Interface-controlled "shrinking-core" model



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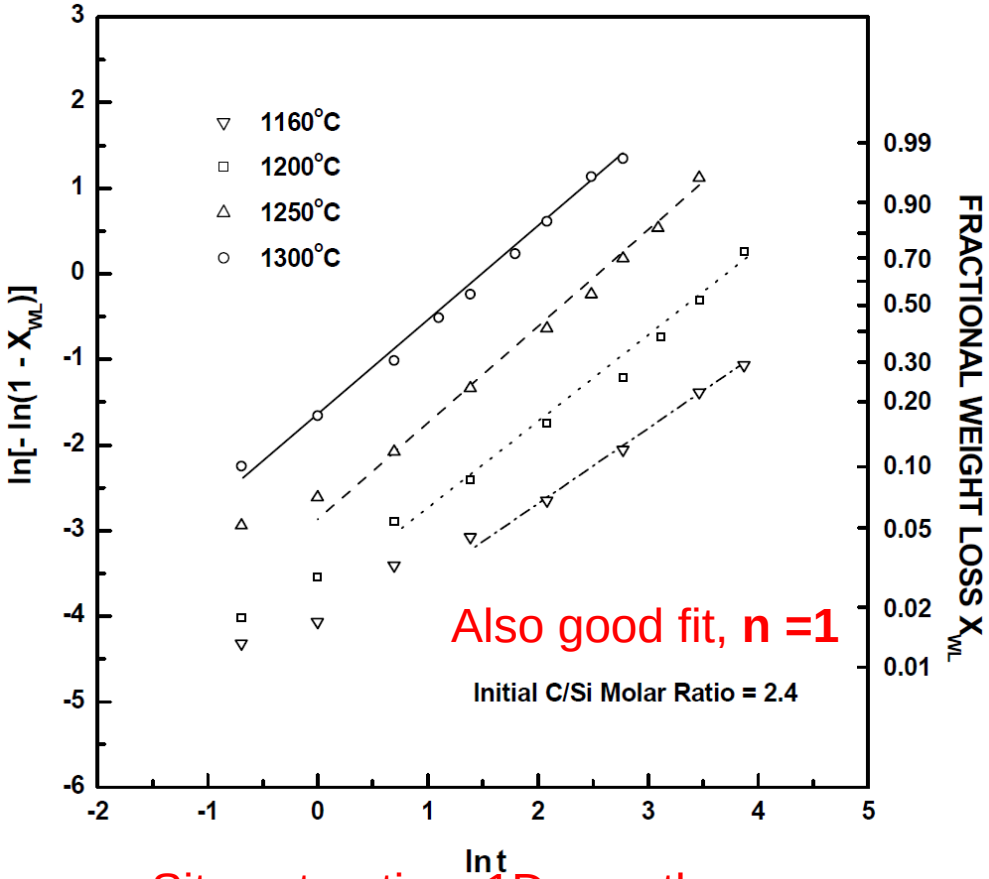
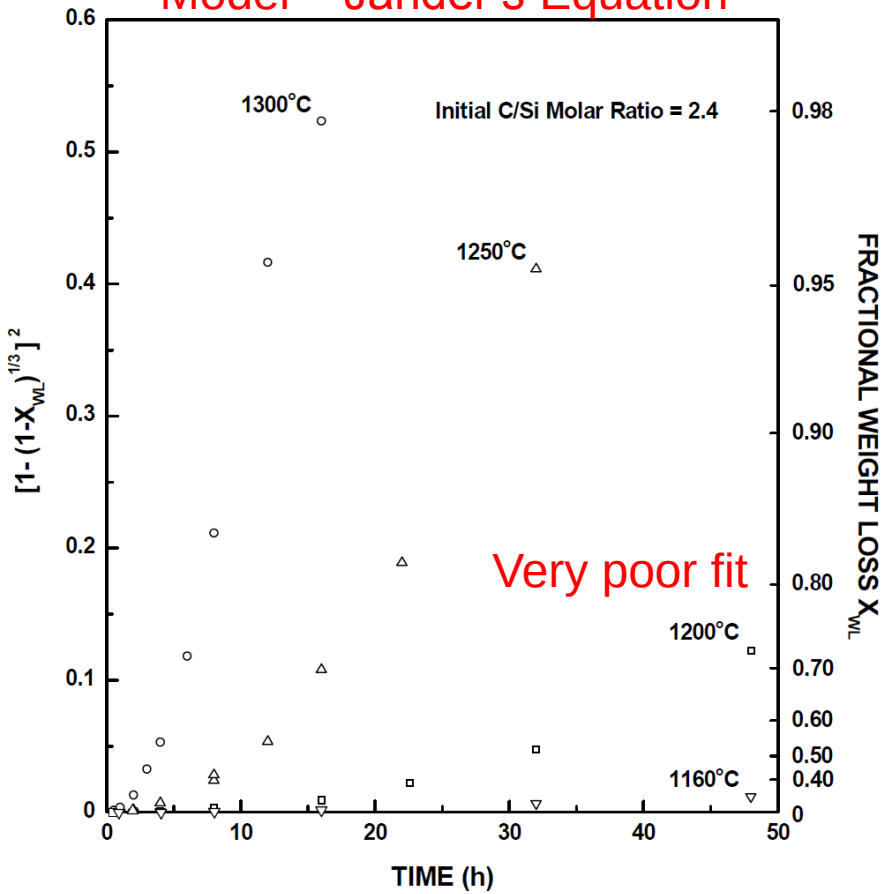
Comparison with Other Kinetic Models

- Good fit also to Nucleation – Growth model

Nucleation – Growth Model



Diffusion-Controlled "Grow In" Model – Jander's Equation



× Site saturation, 1D growth

✓ Constant nucleation - no growth

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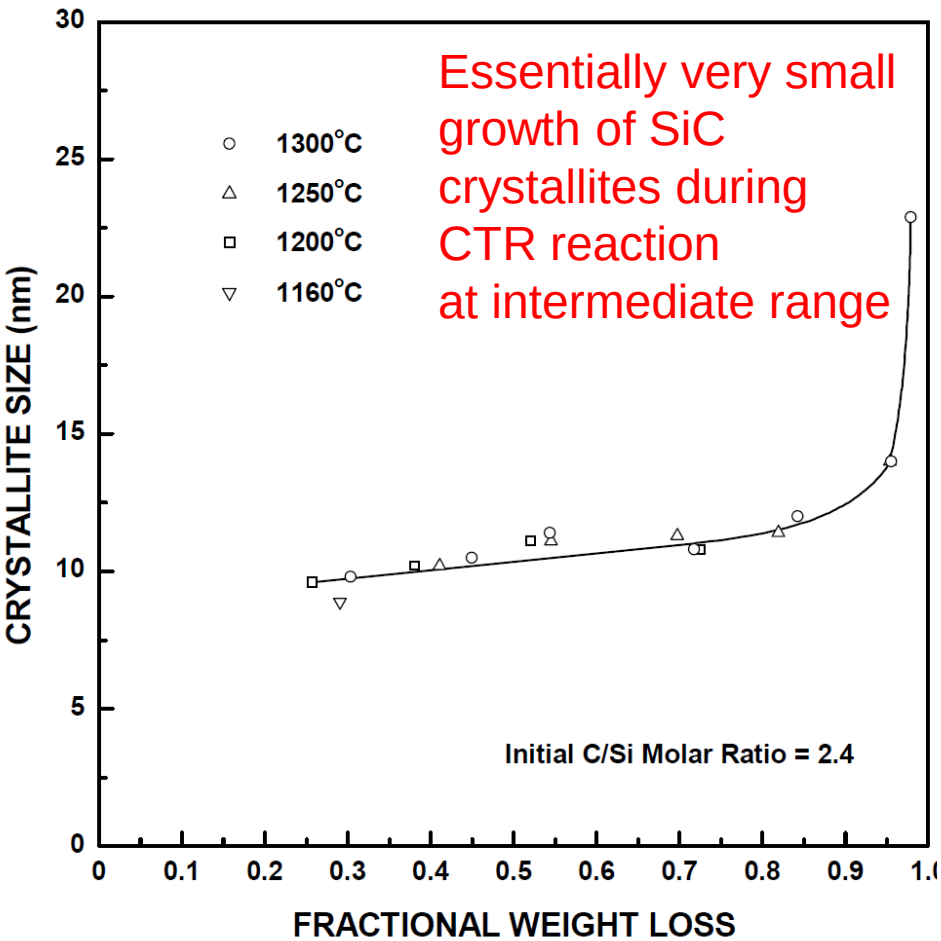
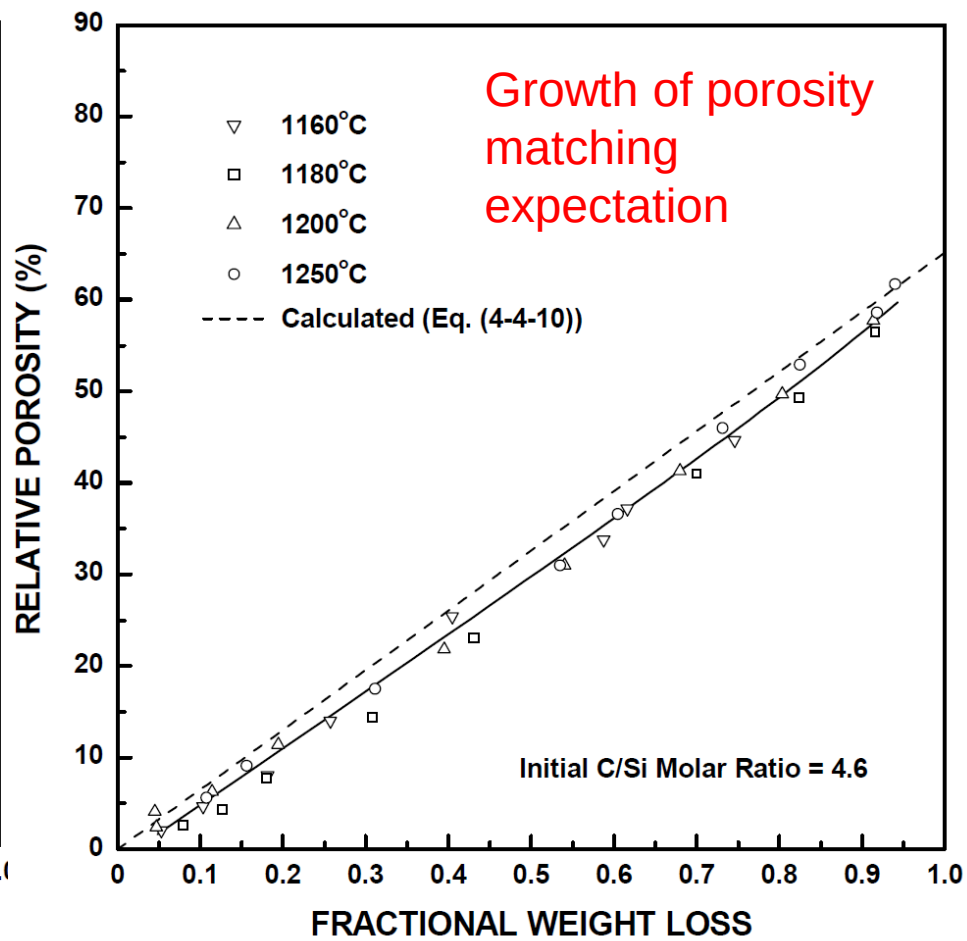
Microstructure Changes to Confirm Reaction Model





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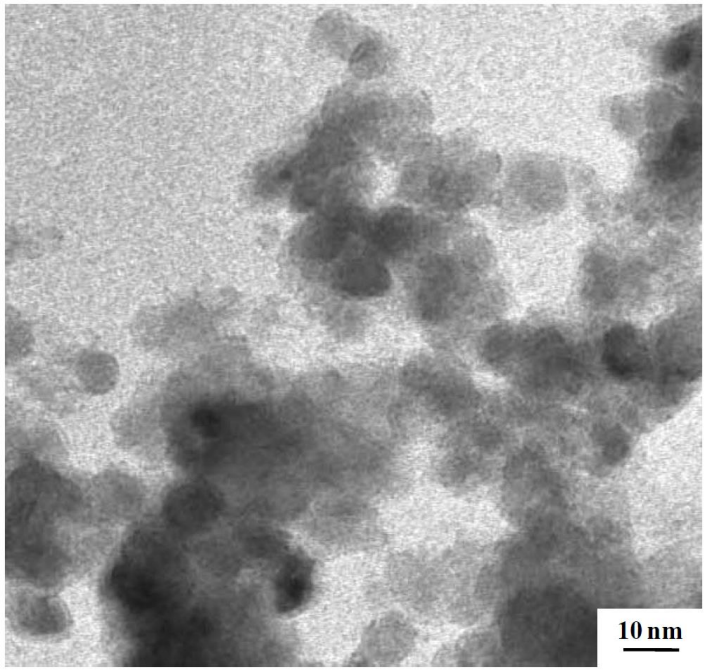
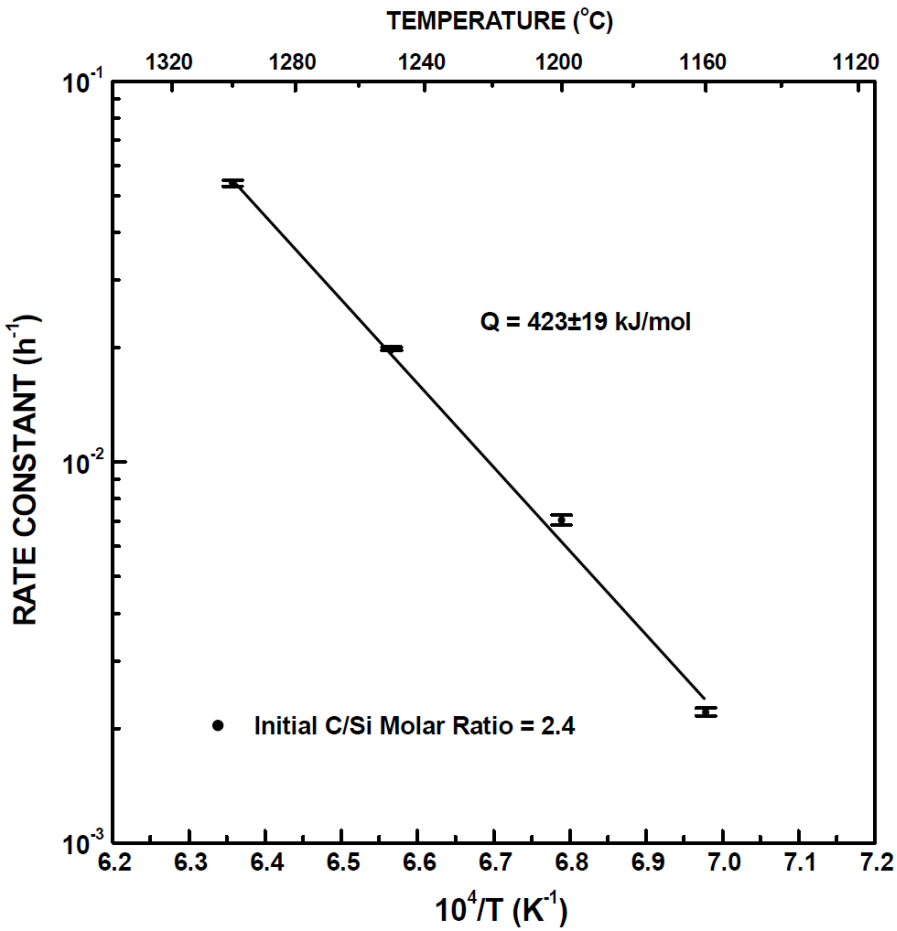
Rate-Limiting Step & Activation Energy

- **Reaction is limited by sub-step of**
  $SiO + C = SiC + 2CO$

For the following reasons

- Always have SiO fomartion
- Shape of SiC dependent largely on C size and not SiO_2 size





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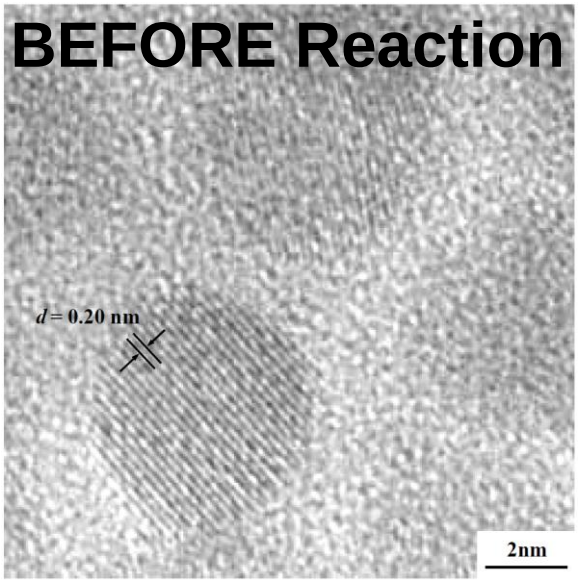
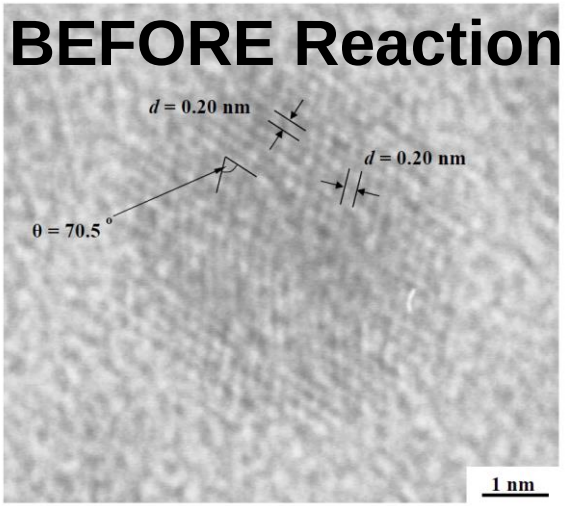
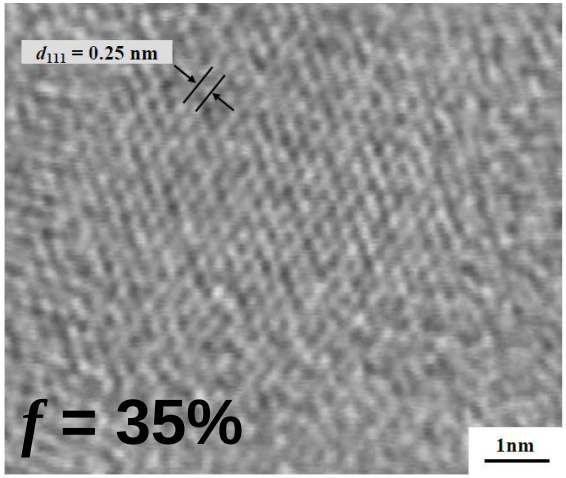
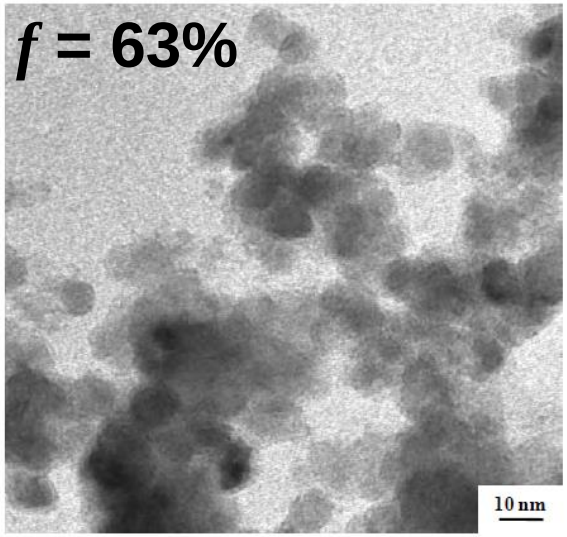
TEM









Little grain growth during reaction

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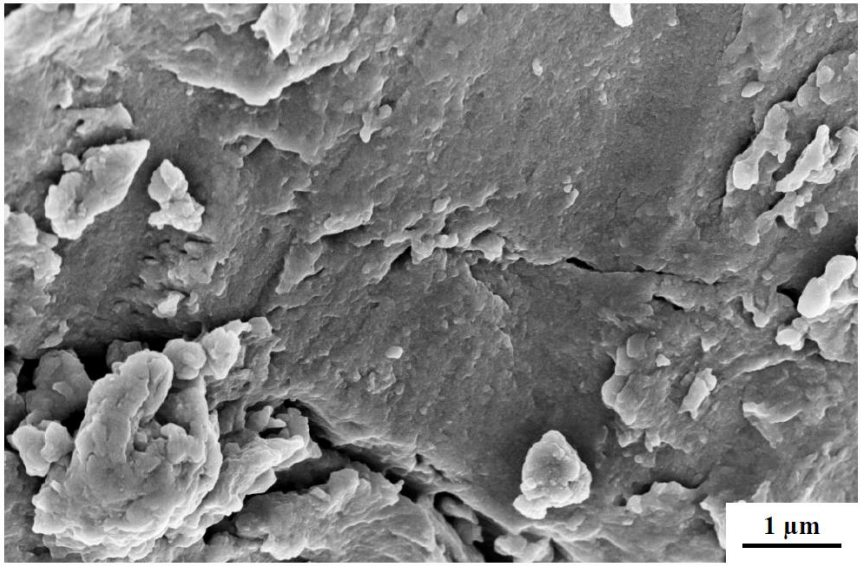
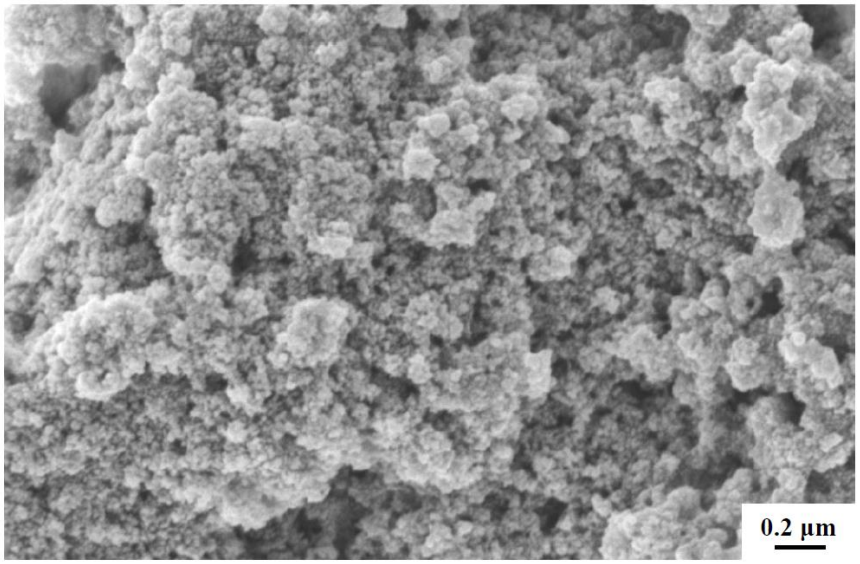
SEM

BEFORE CTR Reaction



f **= 0%**
Almost fully dense

AFTER CTR Reaction



f **= 95%**
Highly porous