The high temperature oxidation of silicon carbide occurs either in a passive or active mode, depending on temperature and oxygen potential. Passive oxidation forms a stable oxide scale, while active oxidation leads to the formation of volatile oxides.

The transition points and rates of active oxidation are important to understand. Previous studies have reviewed the theories of passive-to-active transitions and summarized their findings. The critical factors determining the transition include the oxygen potential and the presence of other elements (e.g., nitrogen). The transition is often accompanied by significant changes in the chemical and physical properties of the oxide scale.

Critical issues include:
- Transitions: active-to-passive
- Rates of active oxidation

Unexplored areas include:
- Hypothesis for SiC: active passive and passive active
- Breakdown of passive film

Theories of Active/Passive Transitions

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Active Concept</th>
<th>Strength</th>
<th>Weakening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wagner[2]</td>
<td>S = SiO + O2 = SiO2</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Girl[3]</td>
<td>Passive Oxide</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Hinz[5]</td>
<td>Breakdown SiO2</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Schneider[6]</td>
<td>Passive-to-active</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

Wagner: Active-to-Passive Transitions for Silicon[2]

Oxygen strikes a bare Si surface, gradually increases PO2, SiC reacts with O2 to form SiO and CO, which leads to the breakdown of the oxide scale.

Pre-Oxidation and the Breakdown of the Passive Scale

- Experiment: Form 0.1, 2, and 4 microns SiO2 scales on SiC[17]
- Expose to known active oxidation environment (100 ppm O2, Ar1500°C)
- Determine how the passive scale breaks down
- Gives insights into the passive-to-active transition

Summary and Conclusions

- Active oxidation of SiC:
  - SiC(s) + 1/2 O2(g) = SiO(g) + CO(g)
- Passive-to-active transition
  - Attain sufficient PO2 to establish the SiO2/SiO scale
- Passive-to-active transition
  - Scale substrate react and SiO(g) product removal pull/' reaction
  - SiC(s) + 2SiO2(g) = 3SiO(g) + CO(g)
- Active oxidation of SiC:
  - SiC(s) + 3/2 O2(g) = SiO(g) + CO(g)

Unexplored areas include:
- The difference between the active-to-passive and passive-to-active transition for SiC.
- Active-to-passive transition
  - Attain sufficient PO2 to establish the SiO2/SiO equilibrium
- Passive-to-active transition
  - Scale substrate react and SiO(g) product removal pull/' reaction
  - SiC(s) + 2SiO2(g) = 3SiO(g) + CO(g)

References